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OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

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Proceedings of the Twenty-seventh Annual Meeting of the American Association of Economic Entomologists

The twenty-seventh annual meeting of the American Association of Economic Entomologists was held at the University of Pennsylvania, Philadelphia, Pa., December 28 to 31, 1914.

The meeting of the section on Apiary Inspection was held at 8 p. m., December 28 and the sessions of the section on Horticultural Inspection convened at 8 p. m. December 29 at the Hotel Walton and at 10.30 a. m. December 30 at the University.

The business proceedings of the Association are given in Part I of this report and the addresses, papers and discussions will be found in Part II.

The proceedings of the sections will be prepared by the section secretaries and published as parts of this report.

The meeting was the largest in the history of the Association, the program was very interesting and all present joined in making it a great success.

PART I BUSINESS PROCEEDINGS

The meeting was called to order by President H. T. Fernald at 1.30 p. m., Monday, December 28, 1914.

Over 200 members and visitors attended the sessions, the average attendance at each session being about 150. The following members were present:

A. J. Ackerman, Washington, D. C.
George G. Ainslie, Nashville, Tenn.
J. M. Aldrich, Lafayette, Ind.
I. L. Bailey, Northboro, Mass.
C. H. Baldwin, Indianapolis, Ind.
Nathan Banks, Washington, D. C.
G. G. Becker, Fayetteville, Ark.
Wm. Beutenmuller, New York City.
F. C. Bishopp, Dallas, Texas.
M. W. Blackman, Syracuse, N. Y.

E. B. Blakeslee, Washington, D. C.
W. E. Britton, New Haven, Conn.
C. T. Brues, Forest Hills, Mass.
A. F. Burgess, Melrose Highlands, Mass.
J. W. Chapman, Forest Hills, Mass.
S. C. Clapp, Raleigh, N. C.
C. R. Cleveland, Durham, N. H.
C. W. Collins, Melrose Highlands, Mass.
Mel. T. Cook, New Brunswick, N. J.
R. A. Cooley, Bozeman, Mont.
G. H. Corbett, London, England.
E. N. Cory, College Park, Md.
G. C. Crampton, Amherst, Mass.
C. R. Crosby, Ithaca, N. Y.
J. J. Davis, Lafayette, Ind.
G. A. Dean, Manhattan, Kans.
M. W. Eddy, State College, Pa.
E. B. Engle, Harrisburg, Pa.
E. P. Felt, Albany, N. Y.
H. T. Fernald, Amherst, Mass.
D. E. Fink, Norfolk, Va.
R. J. Fiske, Washington, D. C.
S. A. Forbes, Urbana, Ill.
B. B. Fulton, Geneva, N. Y.
B. N. Gates, Amherst, Mass.
J. B. Gill, Washington, D. C.
C. P. Gillette, Fort Collins, Colo.
Hugh Glasgow, Geneva, N. Y.
H. A. Gossard, Wooster, Ohio.
C. H. Hadley, Jr., Ithaca, N. Y.
Ernest Hargreaves, London, England.
Leonard Haseman, Columbia, Mo.
W. H. Hasey, Amherst, Mass.
I. M. Hawley, Ithaca, N. Y.
T. J. Headlee, New Brunswick, N. J.
Glenn W. Herrick, Ithaca, N. Y.
P. M. Hertzog, Heightstown, N. J.
C. Gordon Hewitt, Ottawa, Canada.
C. E. Hood, Melrose Highlands, Mass.
C. O. Houghton, Newark, Del.
J. S. Houser, Wooster, Ohio.
L. O. Howard, Washington, D. C.
R. W. Howe, Tallulah, La.
S. J. Hunter, Lawrence, Kans.
W. D. Hunter, Washington, D. C.
J. C. Hutson, Amherst, Mass.
J. A. Hyslop, Hagarstown, Md.
E. O. G. Kelley, Wellington, Kans.
J. L. King, Cleveland, Ohio.
Frederic Knab, Washington, D. C.
J. Kotinsky, Washington, D. C.
G. H. Lamson, Jr., Storrs, Conn.
W. H. Larrimer, Wellington, Kans.
R. W. Leiby, Ithaca, N. Y.
M. D. Leonard, Ithaca, N. Y.
A. D. MacGillivray, Urbana, Ill.
C. L. Marlatt, Washington, D. C.
J. F. Martin, Amherst, Mass.
J. W. McColloch, Manhattan, Kans.
W. R. McConnell, Hagerstown, Md.
L. S. McLaine, Ottawa, Canada.
C. L. Metcalf, Columbus, Ohio.
Z. P. Metcalf, West Raleigh, N. C.
A. P. Morse, Wellesley, Mass.
J. A. Nelson, Washington, D. C.
Henry Ness, Shenandoah, Iowa.
Wilmon Newell, College Station, Texas.
W. C. O'Kane, Durham, N. H.
Herbert Osborn, Columbus, Ohio.
W. A. Osgood, Durham, N. H.
R. R. Parker, Amherst, Mass.
P. J. Parrott, Geneva, N. Y.
L. M. Peairs, Morgantown, W. Va.
W. E. Pennington, Hagerstown, Md.
E. F. Philips, Washington, D. C.
A. L. Quaintance, Washington, D. C.
W. S. Regan, Amherst, Mass.
C. H. Richardson, New Brunswick, N. J.
W. A. Riley, Ithaca, N. Y.
D. M. Rogers, Boston, Mass.
A. G. Ruggles, St. Anthony Park, Minn.
W. E. Rumsey, Morgantown, W. Va.
V. I. Safro, Lexington, Ky.
J. G. Sanders, Madison, Wis.
E. R. Sasscer, Washington, D. C.
H. B. Scammell, Washington, D. C.
W. J. Schoene, Blacksburg, Va.
W. M. Scott, Baltimore, Md.
N. E. Shaw, Columbus, Ohio.
V. E. Shelford, Urbana, Ill.
Franklin Sherman, Jr., Raleigh, N. C.
E. H. Seigler, Washington, D. C.
F. L. Simanton, Washington, D. C.
Henry Skinner, Philadelphia, Pa.
M. T. Smulyan, Blacksburg, Va.
J. N. Summers, Melrose Highlands, Mass.
H. A. Surface, Harrisburg, Pa.
T. B. Symons, College Park, Md.
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E. G. Titus, Logan, Utah.
C. H. T. Townsend, Washington, D. C.
C. F. Turner, Greenwood, Miss.

F. M. Webster, Washington, D. C.
R. L. Webster, Ames, Iowa.
H. B. Weiss, New Brunswick, N. J.
C. B. Williams, Merton, Surry, England.
T. S. Wilson, Wellington, Kans.
Francis Windle, West Chester, Pa.
W. B. Wood, Washington, D. C.
E. L. Worsham, Atlanta, Ga.
L. H. Worthley, Boston, Mass.
W. W. Yothers, Orlando, Fla.

President H. T. Fernald: You will please come to order. We will now listen to the report of the Secretary.

REPORT OF THE SECRETARY

At the time of the last Annual Meeting the membership of the Association was divided as follows: Active, 131; Associate, 189; Foreign, 53; making a total of 373. At the Atlanta meeting four associate members were transferred to the active list and 36 associate members were elected. At that time two associate and one foreign member resigned. Two active members have died and 5 associate members have been dropped from the roll for non-payment of dues. The present membership is 133 active, 212 Associate, 52 Foreign, a total of 397, making a net gain in membership of 24.

During the past year we have lost by death two active members.

Dr. Wm. Saunders, who for many years was Director of the Central Experimental Farm at Ottawa, Canada, died during the summer of 1914. He was one of the older members of the Association and although he was unable to attend our meetings during recent years maintained a great interest in entomology.

Mr. John A. Grossbeck became a member of the Association during the time that he was an assistant to the late Dr. John B. Smith. In recent years he has been on the entomological staff of the American Museum of Natural History of New York.

For several years the income of the Association has been slightly greater than the outgo, so that a moderate surplus has been accumulated. This has been accomplished only by the most rigid economy. During the past year the expenses have overrun the income so that the surplus has been somewhat decreased. This has been partly due to the fact that no dues for 1915 have been collected on account of the pending amendment to the by-laws relative to the change in the amount of annual dues.

The annual net increase in the number of Active members for the past few years has been very small and the net increase in revenue from the new associate members has usually not amounted to more than ten dollars annually.

The Journal of Economic Entomology

The management of the Journal has endeavored to maintain the good reputation that this publication has enjoyed in the past. It has been necessary to cut expenditures severely, which accounts for the delay in publishing the complete proceedings in the first two numbers of the Journal last spring.

The financial success of the Journal depends on the advertising that can be secured. During the past year a number of firms have curtailed their advertising and replacements have not been easy to secure owing to unsettled business conditions. This loss of income has not been made up by new subscribers as our list showed a net increase of only 15 during the past year. The total receipts dropped $225 from those of the previous year and a corresponding decrease in expenditures has been necessary.

The outlook for the coming year as regards the subscription list is not encourag-

ing. Our foreign subscription list will doubtless be cut heavily on account of the war in Europe and the moderate increase of fifty cents in the annual rate to non-members of the Association as suggested by the Advisory Board at the last meeting is necessary to meet existing conditions.

Expenditures by both the Editor and the Secretary have been curtailed during the past year and this has meant that much more personal attention had to be devoted to the publication than heretofore.

The financial statement which follows shows the present condition of the Treasury. A few bills are outstanding because they have not been presented for payment and a number of good accounts are collectible.

Association Statement

Balance in Treasury, December 22, 1913	....	$358.79
By amount received for dues 1914	....	120.94
To stenographic report 1913 meeting	$47.20	
Stamps and stamped envelopes	19.62	
Printing, announcements, etc.	41.50	
Telegraph and express	2.50	
Buttons 1913 meeting	11.12	
Buttons 1914 meeting	11.25	
Cost of Incorporation	3.45	
Clerical work, Secretary's office	30.75	
One half salary of Secretary	50.00	
	$217.39	
Balance, December 22, 1914	262.34	
	$479.73	$479.73

Journal Statement

Balance in Treasury December 22, 1913	....	$335.81
By amount received for subscriptions, advertising, etc., 1914	....	1,578.57
To stamps and stamped envelopes	$38.36	
Printing	1,159.13	
Halftones	86.16	
Miscellaneous supplies	26.82	
Clerical work, Editor's office	32.50	
Clerical work, Manager's office	25.00	
Salary, Editor	100.00	
One-half salary of Manager	50.00	
	$1,517.97	
Balance December 22, 1914	396.41	
	$1,914.38	$1,914.38

Respectfully submitted,

A. F. Burgess,
Secretary.

On motion the report was received and the financial part referred to the Auditing Committee.

SECRETARY A. F. BURGESS: I would like to make a few remarks in regard to the JOURNAL. In 1913 we had a paid up subscription list of 705; in 1914, 720. This does not include copies that go to advertisers and possibly a half dozen free copies which are sent to institutions which carry on bibliographical work. Of the 720 paid subscriptions, 142 went to foreign countries, almost every country in the world being represented. We have a large foreign list of subscribers but I expect that it will be cut very heavily this year on account of the war.

At the last meeting of the Association, the Advisory Committee brought in a report recommending that the subscription price of the JOURNAL be raised 50 cents, provided an amendment to the by-laws raising the dues was accepted at this meeting. We do a large business with subscription agencies. It is necessary for them to prepare catalogues and quote prices in mid-summer. As it was impossible to wait for a decision at this meeting in regard to raising the price of the JOURNAL, I increased it in my quotations to subscription agencies.

We have been receiving a considerable number of subscriptions from Japan during the past year and a noticeable increase of subscriptions to Russia was made during 1914.

I wish to explain this matter so that the members will understand more accurately how the JOURNAL stands at the present time.

PRESIDENT H. T. FERNALD: I will now read the Report of the Executive Committee.

REPORT OF THE EXECUTIVE COMMITTEE

No meeting of the Executive committee has been necessary during the year, only two matters having arisen which needed consideration.

The first of these was a renewal of the invitation by the Managers of the Panama-Pacific Exposition to hold a meeting at San Francisco during the coming summer. After correspondence between the members of the committee it seemed desirable to avoid breaking in on our present custom of holding our regular annual meeting during the Christmas holidays, and the invitation was therefore declined. Since that time certain developments seem to make it desirable to bring this subject before the Association where it will be presented as new business.

The other matter was the preparation of a seal, authorized at the last annual meeting. The committee is not yet ready to make a final report as to what this seal shall represent and can at present only report progress.

H. T. FERNALD,
GLENN W. HERRICK,
W. E. BRITTON,
WILMON NEWELL,
A. F. BURGESS,
Executive Committee.

PRESIDENT H. T. FERNALD: The next on the program is the

report of the Employment Bureau by W. E. Hinds, Auburn, Alabama, which will be read by the Secretary.

ANNUAL REPORT OF ENTOMOLOGISTS' EMPLOYMENT BUREAU

General Statement

The Entomologists' Employment Bureau was established three years ago for the mutual convenience of both employers and employees in entomological work. The service incident to bringing these two parties together has from the first been conducted at the minimum of expense.

Under the administration of Prof. F. L. Washburn who had charge of the Bureau for the first two years of its existence, some twenty men were enrolled and a number of appointments appear to have been made through the agency of the Bureau. The registration fee was reduced from $4.00 to $2.00. No definite limit appears to have been set as to the service offered and no special forms were used in the records of the Bureau. It has seemed necessary therefore to systematize the work somewhat more than was necessary at its inception.

Accordingly enrollment and notification forms, letterheads, etc., have been prepared so that we may be in position to give prompt and effective service with a minimum of clerical expense. The information needed by applicants for enrollment is printed on the application form itself. Ten references to possible employers are offered with one registration fee. An abstract of the enrollment record, with full addresses of parties whose names are given as references is now sent to the possible employer and a notice of the opening for which a man is apparently prepared is sent to each man whose name has been suggested in connection therewith.

These changes in method of administration are working satisfactorily. It happens occasionally, however, that an applicant moves for some reason without sending us his new address, thus putting us out of touch with him for a time at least. It would help the Bureau to become of greater service if we may have a little more general coöperation in the following points especially: First, Prompt notification of changes in the applicant's address. Second, More general notification by employers regarding positions for which names of candidates may be desired. Our service is free to employers and we can frequently suggest the names of several men having the general qualifications required so that the employer may have a choice among several good men. Third, We need more general information regarding appointments, especially when made through the agency of the Bureau and when men enrolled with the Bureau accept work either temporary or permanent, which might change their status as applicants whose names we might present for immediate appointments.

Since March 3, 1914, we have added nineteen (19) new names to the enrollment list and at least eight (8) appointments have been made from names supplied by the Bureau. A full financial statement is presented herewith.

W. E. Hinds,
In Charge.

Financial Statement

Received

March 3, 1914, To check of F. L. Washburn covering balance on hand	$32.25
March to December, To nineteen (19) new registrations	38.00
Total receipts	$70.25

Paid

August 25, 1914, Printing and stationery, Post Publishing Co....		$11.00
October 5, Post Publishing Co.		2.00
April 9, August 29, November 5. Labor multigraphing letters: $1.00, 75c, 75c		2.50
Postage		7.24
Envelopes and letter heads furnished by A. P. I., Dept. of Entomology		2.50
December 22, Stenographer, N. C. Powell		18.00
Total expenditures		$43.24
Balance, in Bank of Auburn		27.01
	$70.25	$70.25

W. E. Hinds,
In Charge.

On motion the report was adopted and the financial part referred to the Auditing Committee.

Secretary A. F. Burgess: I notice that Mr. Hinds emphasizes the necessity for members notifying him promptly of any change of address. I want to make the same point in regard to subscribers to the Journal. Entomologists are a very migratory set of people and if you had the mailing list of the Journal to correct for each issue, you would realize that fact. In order to assure delivery of the publication as it is issued, it is necessary that the members should promptly notify concerning any change of address.

President H. T. Fernald: The report of the Committee on nomenclature will now be presented by Mr. Herbert Osborn, Columbus, Ohio.

REPORT OF COMMITTEE ON COMMON NAMES OF INSECTS OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

The only case which has been submitted to your committee during the past year has been a petition from Dr. H. J. Franklin of Amherst, Mass., to the effect that the names of certain cranberry insects, the Black-head Cranberry Worm and the Yellow-head Cranberry Worm, names which were adopted on the initiative of Prof. J. B. Smith, should be changed to the Flowed Bog Fireworm, *Rhopobota vacciniana* (Pack.) and the Dry Bog Fireworm, *Peronea minuta* (Rob.).

Dr. Franklin's argument in brief is that the names suggested are more distinctive of the habits of the species concerned and that the previous names are less distinctive and less suggestive to the practical cranberry growers who are especially interested in the use of these names.

Your committee feels that it is undesirable to make changes of names already adopted except in case of very positive reasons and would present the case to the Society without recommendation.

We will be pleased to have the matter discussed at this meeting and the opinions of those entomologists most familiar with the species considered in the discussion.

Respectfully submitted,

Herbert Osborn,
W. E. Britton,
E. P. Felt,
Committee.

Secretary A. F. Burgess: It seems to me that it would be well for the committee to take up the suggested changes with the entomologists that are particularly interested in cranberry insects and bring in a recommendation later to the Association. Cranberries are grown only in limited sections of the country, and there are therefore only a limited number of our members interested in these insects. It ought to be possible for the committee to consult with these men and get the consensus of opinion in regard to the proposed changes in names.

On motion, the report was referred back to the committee with instructions to report later.

President H. T. Fernald: Next is the report of the committee on entomological investigations which will be read by Glenn W. Herrick, Ithaca, N. Y.

REPORT OF THE COMMITTEE ON ENTOMOLOGICAL INVESTIGATIONS

December 23, 1914

Mr. President:

The Committee on Entomological Investigations presents its report and begs leave to make the following remarks:

The notice to the different entomologists was sent out a little late, owing to a confusion regarding the organization of the Committee. However, about the same number have reported as usual. In addition, we have this year for the first time, the long list of most admirable projects of the Bureau of Entomology at Washington.[1] Lists of projects of other entomologists are not readily accessible and are therefore reproduced below.

Glenn W. Herrick,
Walter C. O'Kane,
T. J. Headlee,
Committee.

Investigations Dealing with Mammalia

Nebraska, Lincoln,—Myron H. Swenk.

The prairie-dog. Substantial progress. Preliminary publication contemplated.

New Mexico, State College,—D. E. Merrill.

Prairie-dogs. Data on distribution, numbers, damage, control.

Rodents. Tests of poisons, traps, etc. Scattering.

[1]This latter is not reprinted, since it appears in the "Program of Work of the United States Department of Agriculture for the Fiscal Year 1915" and may be readily obtained by interested parties.

Investigations Dealing with Crustacea

Mississippi, Agricultural College,—R. W. Harned.

The crayfish of Mississippi. Slight progress during the year.

Investigations Dealing with Mollusca

Oregon, Corvallis,—H. F. Wilson.

The garden slugs. Begun 1913. A. L. Lovett in immediate charge.

Investigations Dealing with Acarina

Connecticut, New Haven,—W. E. Britton.

Control of Greenhouse Mite, *Tarsonemus pallidus* Banks. Begun 1914. Q. S. Lowry aiding.

Montana, Bozeman,—R. A. Cooley.

Tick investigations with particular reference to *Dermacentor venustus*.

North Carolina, Raleigh,—Franklin Sherman, Jr.

Red spider on cotton. Life history, habits; begun last year; continued.

New York, Geneva,—P. J. Parrott.

Monographic study of the *Eriophyidæ* of N. Y. In charge of H. E. Hodgkiss.

Investigations Dealing with Thysanoptera

Connecticut, New Haven—W. E. Britton.

Control of Onion Thrips, *Thrips tabaci* Linde. Begun 1913. B. H. Walden aiding.

New York, Geneva,—P. J. Parrott.

Life history, habits, distribution in New York of the pear thrips, *Euthrips pyri*.

Investigations Dealing with Mallophaga and Anoplura

California, Stanford University,—V. L. Kellogg.

Taxonomic and biologic studies of the Mallophaga and Anoplura. (With G. F. Ferris). Generic and specific revision of the North American Anoplura. Work under way.

New York, Cornell University, Ithaca,—Glenn W. Herrick.

The Mallophaga of domestic fowls. Ready for publication.

Investigations Dealing with Isoptera

Kansas, Manhattan,—George A. Dean and J. H. Merrill.

A study of the termite (*Termes lucifugus*).

Investigations Dealing with Orthoptera

Hawaii, Honolulu,—J. F. Illingworth.

Monograph of Hawaiian Roaches, begun 1913, well under way.

Idaho, Boise,—T. H. Parks.

Snowy tree cricket (*Oecanthus niveus*). Injuries to ripening prunes. Begun 1914.

Kansas, Lawrence,—S. J. Hunter.

Acridinæ of Kansas, taxonomic, economic and biologic phases. P. W. Claassen in charge.

Remedial measures against native grasshoppers. S. J. Hunter and P. W. Claassen.

Kansas, Manhattan,—George A. Dean.

Habits and life history, control of injurious grasshoppers. George A. Dean.

Parasitic and predaceous enemies of grasshoppers. Paul S. Welch.

Nebraska, Lincoln,—Myron H. Swenk.

Grasshopper control. Lawrence Bruner in charge. Substantial progress.

New York, Albany,—E. P. Felt.

Grasshoppers of New York, control. Considerable data. Begun 1914.

New York, Geneva,—P. J. Parrott, B. B. Fulton.

Life histories, habits and control of tree crickets, *O. niveus* and related species.

Oregon, Eugene,—C. F. Hodge.

Methods of collecting and preserving grasshoppers for game bird and poultry food.

Investigations Dealing with Hemiptera

Arkansas, Fayetteville,—George C. Becker.

(1) Supposed immunity of Northern Spy stock to the attacks of woolly aphis.

(2) Studies of the relationship of woolly aphis to its various hosts. Substantial progress.

Colorado, Boulder,—T. D. A. Cockerell and Elizabeth Robinson.

Coccidæ of Colorado and Philippine Islands. One paper published; second about to be published.

Colorado, Fort Collins,—C. P. Gillette.

Plant aphids. Several years' progress. Much data accumulated; two papers published.

Florida, Gainesville,—J. R. Watson.

White fly studies.

Idaho, Boise,—T. H. Parks.

Clover aphis (*Aphis bakeri*). Begun 1913; studied as an enemy of red clover and apple foliage.

Indiana, Indianapolis,—C. H. Baldwin.

Coccidæ of Indiana. Distribution, control of greenhouse species. H. F. Dietz in charge.

Maine, Orono,—Edith M. Patch.

Aphid ecology. Begun 1904. Progress slow but constant.

Mississippi, Agricultural College,—R. W. Harned, E. W. Stafford.

Scale insects of Mississippi (food habits, life history of native species).

Missouri, Columbia,—L. Haseman.

Tarnished plant bug and its work on peach and other plants.

Apple leaf hopper.

Control of the San José scale. L. Haseman and A. H. Hollinger.

Missouri, Mountain Grove,—M. P. Somes.

Life history and control of the San José scale. Satisfactory progress.

Life history and control of *Jalysus spinosus*. Practically complete.

Montana, Bozeman,—R. A. Cooley.

Life history and control of sugar beet louse (*Pemphigus betæ*). J. R. Parker in charge.

Control of the oyster shell scale by use of insecticides.

Iowa, Ames,—R. L. Webster.

Oyster shell scale, *Lepidosaphes ulmi*. Begun 1908. Progress satisfactory.

Kansas, Lawrence,—S. J. Hunter.

Aspidiotus perniciosus, study of means of distribution and methods of control.

Aspidiotus perniciosus, study of the natural parasites. P. W. Claassen.

Blissus leucopterus, control measures. S. J. Hunter and P. W. Claassen.

Woolly aphis, H. B. Hungerford.

Toxoptera graminum, Ruby Hosford.

Kansas, Manhattan,—Geo. A. Dean.

Chinch bug control. Geo. A. Dean and J. W. McColloch.

Chinch bug egg parasite. J. W. McColloch.

Control of San José scale. J. H. Merrill.

New York, Albany,—E. P. Felt.

Efficiency of San José scale parasites. Preliminary report in type. Begun in 1913.

New York, Geneva,—P. J. Parrott.

Life history, habits, control in pear orchards of false tarnished plant-bug, *Lygus invitus* Say. H. E. Hodgkiss in immediate charge.

Control of late summer broods of the pear psylla. H. E. Hodgkiss in immediate charge.

Life history, habits, control of grape leaf hopper. F. Z. Hartzell in immediate charge.

New York, Cornell University, Ithaca,—Glenn W. Herrick.

Green apple aphis (*Aphis pomi*). Robert Matheson in full charge.

Rosy apple aphis (*Aphis sorbi*). Robert Matheson in full charge.

Pine leaf scale (*Chionaspis pinifoliæ*). Robert Matheson in full charge.

Ohio, Wooster,—H. A. Gossard.

Biological and economic studies of plant lice, especially in orchards.

Distribution of Periodical Cicada, 1914 brood; coöperation with Biological Survey and State Bureau of Nursery Inspection.

Experiments for control of jassids or leaf-hoppers in grasslands planned.

Scale insects and remedies; much experimental data. J. S. Houser in immediate charge.

Woolly aphis. Several years' work, not much progress. J. S. Houser in immediate charge.

Research on Pentatomidæ. Several life histories practically complete. R. D. Whitmarsh in immediate charge.

Oregon, Corvallis,—H. F. Wilson.

Rose-leaf hopper as a fruit tree pest (*Empoa rosæ*). Begun July 1, 1914. Leroy Childs aiding.

South Carolina, Clemson College,—A. F. Conradi.

Aphis maidi-radicis on cotton; life history, food plants, ants, repellants, control. Begun 1909. W. A. Thomas in charge.

South Dakota, Brookings,—H. C. Severin.

Investigations of the scale insects of South Dakota. Begun in 1912.

Tennessee, Knoxville,—E. C. Cotton.

The hog louse.

Texas, College Station,—Wilmon Newell.

Turnip louse (*Aphis pseudobrassicæ*). Well advanced; preliminary publication being prepared. F. B. Paddock in charge. Begun in 1913.

Virginia, Blacksburg,—W. J. Schoene.

Spinach aphis (*Myzus persicæ*), control, L. B. Smith in charge; project started spring of 1914.

Pea-aphis (*Macrosiphum pisi*) biology and control, L. B. Smith in charge; project started spring of 1914.

Biology and the control of the three species of the aphis affecting the apple. *Aphis pomi, Aphis sorbi* and *Siphocoryne avenæ.* W. J. Schoene and M. T. Smulyan in charge; project started spring of 1914.

Effect of woolly aphis (*Schizoneura lanigera*) on apple trees. W. J. Price in charge; continuation of a project of several years' standing.

West Virginia, Morgantown,—L. M. Peairs.
Control of apple woolly aphis. Work along new lines merely started.

INVESTIGATIONS DEALING WITH LEPIDOPTERA

Arkansas, Fayetteville,—George C. Becker.
Life history, control of *Sanninoidea exitiosa.* Substantial progress.

Colorado, Fort Collins,—C. P. Gillette.
Codling moth; in progress for several years. Much data.

Hawaii, Honolulu,—J. F. Illingworth.
Palm-leaf roller (*Omoides blackburni* Butl.), seasonal activity, life history, parasites. Begun 1913, well under way.

Indiana, Indianapolis,—C. H. Baldwin.
Apple-leaf skeletonizer, life history, control. Begun 1914. Progress satisfactory.

Indiana, Lafayette,—James Troop.
Life history, control, codling moth. Begun 1913. Will run one or two years more.

Iowa, Ames,—R. L. Webster.
Strawberry leaf-roller (*Ancylis comptana*). Begun 1913. Considerable data.
Variegated cutworm (*Peridroma margaritosa*). Begin in 1914. Many observations.
Corn-ear worm (*Heliothis obsoleta*). Seasonal history. Begun in 1914.

Kansas, Lawrence,—S. J. Hunter.
Codling moth, control. S. J. Hunter and P. W. Claassen.
Indian meal-moth, life history and economic importance. S. J. Hunter & R. H. Beamer.
Cut-worms and army-worms, economic phases. H. B. Hungerford and Geo. H. Vansell.
Bee-moth. Geo. H. Vansell.

Kansas, Manhattan,—Geo. A. Dean.
Life history and control of the the corn-ear worm. J. W. McColloch.
Life history and control of the apple-leaf skeletonizer (*Canarsia hammondi*). J. H. Merrill.

Maryland, Baltimore,—W. M. Scott.
Experiments for the control of the peach tree borers. Begun 1913.

Missouri, Columbia,—L. Haseman.
Life history; paints for control of peach tree borer. L. Haseman and M. E. Hays.
Life history, injury, control of corn-ear worm. M. E. Hays.

Missouri, Mountain Grove,—M. P. Somes.
Life history and control of peach tree borer. Considerable progress.

Montana, Bozeman,—R. A. Cooley.
Life histories and control of cutworms.

Nebraska, Lincoln,—Myron H. Swenk.
Cutworm injury to Nebraska crops. Considerable data.

New Jersey, New Brunswick,—T. J. Headlee.
Corn-ear worm investigations; methods of applying powdered poisons. C. H. Richardson and T. J. Headlee; see Rept., 1913.
Peach borer: study of protective coatings. H. B. Weiss and T. J. Headlee. See Repts., 1913, 1914.

New York, Albany,—E. P. Felt.
Efficiency of codling moth sprays. Mostly published. Begun in 1909.

New York, Geneva,—P. J. Parrott.

Life history, habits, distribution of the apple and cherry ermine moths.

Life histories of species of *Xylina* and *Scopelosoma.* B. B. Fulton in immediate charge.

Ohio, Wooster,—H. A. Gossard.

Life history of codling moth at Wooster; some data, studies of second brood in all sections of state.

Life history and economics of clover leaf-roller. Notes for three or four seasons.

Control of grapeberry worm. Experimental work practically finished. Life history incomplete. W. H. Goodwin in charge.

Life history and control of peach tree borer; two years' observations; substantial progress; large remedial tests. J. L. King in immediate charge.

Life history and treatment for the lesser peach borer, as in preceding.

Pennsylvania, Harrisburg,—H. A. Surface.

Experiments for control of the peach tree borer. Work completed.

South Dakota, Brookings,—H. C. Severin.

Life history and control of native cutworms. Begun in 1910.

Investigations Dealing with Diptera

Colorado, Fort Collins,—C. P. Gillette.

Syrphus flies and plant lice; continued three years; considerable material. C. R. Jones in immediate charge.

Life habits of the lady beetles. Paper published. Miss M. A. Palmer in immediate charge.

Connecticut, New Haven,—W. E. Britton.

Cabbage maggot control. Begun 1908. Q. S. Lowry aiding.

Onion maggot control. Begun in 1914. B. H. Walden aiding.

Connecticut, New Haven,—W. E. Britton.

Control of mosquitoes in Connecticut; effect of drainage on salt marsh; changes in flora. Begun 1912. B. H. Walden aiding.

Hawaii, Honolulu,—J. F. Illingworth.

Melon flies (*Dacus cucurbitæ* Coq.), control measures, begun 1914, well started.

Kansas, Lawrence,—S. J. Hunter.

Tabanidæ of Kansas, R. H. Beamer.

Simulium, study of connection with transmission of Pellagra. S. J. Hunter.

Similium, Ecology and morphology. H. B. Hungerford.

Hessian fly, methods of control. S. J. Hunter and P. W. Claassen.

Kansas, Manhattan,—Geo. A. Dean.

Life history and control of the Hessian fly. Geo. A. Dean and J. W. McColloch.

Massachusetts, Amherst,—H. T. Fernald.

Control of onion maggot on large fields. Progress satisfactory.

Missouri, Columbia,—L. Haseman.

Life history of the Hessian fly and resistant varieties of wheat.

New Hampshire, Durham,—W. C. O'Kane and C. H. Hadley, Jr.

Control of root maggots with insecticides; two seasons' preliminary work completed.

Control of black flies, deer flies and midges. In progress.

New Jersey, New Brunswick,—T. J. Headlee.

Typhoid fly: Data necessary for practical control work of it and its associates. Charles S. Beckwith and T. J. Headlee in 1913, C. H. Richardson in 1914. See reports 1913, 1914.

Mosquito investigations: Data for practical control work. T. J. Headlee. See reports 1913, 1914, also Circ. 17.

New York, Albany,—E. P. Felt.

Monographic study of biology and taxonomy of gall midges. Partly published, much in manuscript. Begun in 1906.

New York, Geneva,—P. J. Parrott.

Life history, habits, control of the grape midge. F. Z. Hartzell in immediate charge.

Life history, habits, control of cabbage maggot; a special study of the reaction of puparia to heat and desiccation; methods of protecting seed beds. Ready to report. W. J. Schoene.

Ohio, Wooster,—H. A. Gossard.

Onion maggot. Observations for two seasons, substantial progress. J. S. Houser in immediate charge.

Oregon, Eugene,—C. F. Hodge.

Control of house and stable flies, especially community coöperation in practical extermination. Begun 1910.

Preventing mosquito breeding in agricultural districts; in conjunction with class in biology.

Investigations Dealing with Coleoptera

Alabama, Auburn,—W. E. Hinds.

Life history, control of rice or black weevil, *Calandra oryza.* Substantial progress. Begun 1908. Partly published.

Arkansas, Fayetteville,—George C. Becker.

Life history, habits, control of *Saperda candida:* (1) life history and habits, (2) control. Substantial progress.

Connecticut, New Haven,—W. E. Britton.

Life history and control of white pine weevil, *Pissodes strobi* Pk. Begun 1911. B. H. Walden aiding.

Hawaii, Honolulu,—J. F. Illingworth.

Cucurbit stem borer (*Apomecyna pertigera* Thoms.), life history, control, begun 1913, well under way.

Monkey pod borer (*Xystrocera globosa* Oliv.), begun 1914, well under way.

Iowa, Ames,—R. L. Webster.

White grub investigations. Begun in 1914; coöperation U. S. Bureau of Entomology.

Kansas, Lawrence,—S. J. Hunter.

Elm-tree borers, life history and control measures, Walter Wellhouse.

Cottonwood borer, parsites of. H. B. Hungerford.

Kansas, Manhattan,—Geo. A. Dean.

Life history, control of maize bill bug (*Sphenophorus maidis*). J. W. McColloch and W. P. Hayes.

Missouri, Columbia,—L. Haseman.

Life history and control of the striped cucumber beetle.

Life history, injury and control of the elm-tree borer.

Missouri, Mountain Grove,—M. P. Somes.

Life history and control of the fruit-tree bark-beetle. Considerable data.

New York, Albany,—E. P. Felt.

Ecology and control of June beetles and white grubs. Partly published. Begun in 1912.

New York, Geneva,—P. J. Parrott.

Life history, control of the rose chafer. F. Z. Hartzell in immediate charge.

Life history, habits, control of grape root worm. F. Z. Hartzell in immediate charge.

Life history, control of the sinuate borer (*Agrilus sinuatus*). Hugh Glasgow in immediate charge.

Distribution, life history, control of *Polydrosus impressifrons*. Hugh Glasgow in immediate charge.

New York, Cornell University, Ithaca,—Glenn W. Herrick.

Poplar borer (*Cryptorhynchus lapathi*). Robert Matheson in full charge.

Ohio, Wooster,—H. A. Gossard.

Life history and systematic studies of long-horned wood-borers in Ohio; continued several years. W. H. Goodwin in immediate charge.

Life history and study of the *Balininæ* or nut weevils of Ohio; continued several years. W. H. Goodwin in immediate charge.

General study of the various bark beetles in Ohio; substantial progress. J. L. King, in immediate charge.

Oregon, Corvallis,—H. F. Wilson.

Otiorhynchid beetles infesting the strawberry in Oregon. Begun July 1, 1914. G. F. Moznette aiding.

Cucumber beetles (*Diabrotica soror* and *D. trivittata*). Begun 1913. A. L. Lovett in immediate charge.

Scolytidæ infesting the Douglas fir (*Pseudotsuga taxifolia* (Pow.)Britt.). Begun 1912. Leroy Childs aiding.

South Carolina, Clemson College,—A. F. Conradi.

A study of new and little known wire-worms of field crops. Begun 1909.

Life histories, food plants, habits, control of *H. uhleri* and *Monocrepidius vespertinus*. Substantial progress.

Above in coöperation with the Section of Southern Field Crop insects, Bureau of Entomology, H. C. Eagerton in charge.

Texas, College Station,—Wilmon Newell.

Pecan twig girder (*Oncideres texana*). Sherman W. Bilsing in charge. Material progress, begun 1913.

Pea and bean weevils; practical control. Work begun. Wilmon Newell and associates.

Wisconsin, Madison,—J. G. Sanders.

Control of white grubs. Begun 1914. Progress satisfactory.

Investigations Dealing with Hymenoptera

Colorado, Boulder,—T. D. A. Cockerell.

Bees of the world; principally those of North America and Australia.

Hawaii, Honolulu.—J. F. Illingworth.

Predaceous habits of big-headed ant (*Pheidole megacephala* Fab.), notes from Fiji Islands and Hawaii, begun 1913, half completed.

Indiana, Indianapolis,—C. H. Baldwin.

Control of house ants. Begun 1914.

Kansas, Lawrence,—S. J. Hunter.

Bees and their diseases. Geo. H. Vansell.

Bees and poison bait. Geo. H. Vansell.

Kansas, Manhattan,—Geo. A. Dean.

A study of the kaffir ant (*Solenopsis molesta*). J. W. McColloch and W. P. Hayes.

Missouri, Columbia,—L. Haseman

A study of beekeeping in Missouri.

New Jersey, New Brunswick,—T. J. Headlee.

Bee disease control: E. G. Carr and T. J. Headlee. See reports for 1913, 1914.

New York, Geneva,—P. J. Parrott.

Life history, habits, control of the saw fly leaf miner (*Profenusa collaris* MacG). B. B. Fulton in immediate charge.

Oregon, Corvallis,—H. F. Wilson.

Raspberry and loganberry rootborer (*Bembecia marginata*). Begun 1913. A. L. Lovett in immediate charge.

Texas, College Station,—Wilmon Newell.

A study of inheritance in the honey bee. Material progress. Begun in 1911.

Beekeeping experiments.

Practical experiments relating to honey production. Begun in 1912.

Wisconsin, Madison,—J. G. Sanders.

Wisconsin beekeeping conditions. Begun in 1912. L. V. France in charge.

Investigations dealing with Groups of Insects or with Insecticides or with both

Alabama, Auburn,—W. E. Hinds.

Carbon bisulphide and hydrocyanic acid gas as insecticides. Begun 1908. Continued progress.

Factors affecting the distribution, adhesion, economy of application and efficiency of arsenical insecticides with particular reference to arsenate of lead; begun 1913. Substantial progress.

Colorado, Boulder,—T. D. A. Cockerell.

Insects of Colorado, principally those of Boulder County.

Fossil insects especially of Florissant, Colorado (Principally Diptera and Hymenoptera.)

Colorado, Fort Collins,—C. P. Gillette.

Control of insects by treatment of the eggs. Conducted for several years, much data.

Connecticut, New Haven,—W. E. Britton.

Preparation and application of nicotine solutions as insecticides. Begun 1914. A few extractions and analyses made. J. P. Street aiding.

Study of insects attacking the apple in Connecticut. Begun 1907. Studies completed on several insects and papers published.

Insects attacking the peach in Connecticut. Extent of damage and methods of control. Begun 1907. Studies of a number of the more important pests made.

Control of peach and apple borers in Station orchard. Begun 1911. Considerable data.

Insects attacking cabbage in Connecticut. Substantial progress. Begun 1912. Q. S. Lowry aiding.

Insects attacking vegetables in Connecticut. Begun 1908. Substantial progress.

Insects attacking white pine in Connecticut. Begun 1912. Some progress. B. H. Walden aiding.

Indiana, Indianapolis,—C. H. Baldwin.

Control of greenhouse pests by fumigation and spraying. Begun 1914. A. P. Swallow in charge.

Kansas, Lawrence,—S. J. Hunter.

Alfalfa insects. Wm. Brown.

Spraying; relative efficiency of lime-sulphur and scalecide. P. W. Claassen.

Spraying; effects of successful seasonal spraying on succeeding seasons' crops. S. J. Hunter and P. W. Claassen.

Optimum and fatal temperatures for insect life. Ruby Hosford and Wm. Brown.

Kansas, Manhattan,—Geo. A. Dean.

Relation of climate to injurious insects. Geo A. Dean and J. W. McColloch.

Measures of controlling mill and stored grain insects. Geo. A. Dean.

Maryland, Baltimore,—W. M. Scott.

Development of a dry material for use as a substitute for lime-sulphur solution. Begun 1913.

Experiments with arsenate of lime or calcium arsenate as a substitute for arsenate of lead. Begun 1913. Nearly completed.

Massachusetts, Amherst,—H. T. Fernald.

Causes producing burning of foliage by insecticides. Progress satisfactory.

Real amount of benefit obtained from different groups of parasites. Progress satisfactory.

Distribution limits of pests in Massachusetts. Progress satisfactory.

Strength of fumigation safe on different greenhouse crops as compared with strength necessary for destruction of the pests. Temporarily discontinued.

Michigan, East Lansing,—R. H. Pettit.

How contact insecticides kill. E. G. Shafer in immediate charge.

Life histories and control of various fruit and field crop insects.

Life histories and control of insects injurious to Michigan forests and shade trees. G. C. Goodwin in immediate charge.

Missouri, Columbia,—L. Haseman.

Life histories, distribution, injury and control of insects affecting nursery stock.

Nebraska, Lincoln,—Myron H. Swenk.

The rôle of insects in tripping alfalfa blossoms and effect of tripping on size of seed crop. Progress satisfactory. Preliminary publication contemplated.

A monographic account of the insect enemies of alfalfa. Progress satisfactory.

New Jersey, New Brunswick,—T. J. Headlee.

Spraying and dusting investigations: Effectiveness of certain new dusts in controlling insects and diseases affecting orchard fruits and potato foliage; former this year in charge department of plant pathology and latter in charge of department of entomology. H. B. Weiss, C. H. Richardson and T. J. Headlee in 1913; Alfred E. Cameron in 1914. See reports for 1913, and 1914.

Climatic and insect investigations: Effect of maximum and minimum temperatures on various seriously injurious insects. C. H. Richardson and T. J. Headlee. No printed records of progress thus far.

Insect control: Facts relative to importation of injurious insects from Foreign countries; control of outbreaks of established insects. H. B. Weiss and T. J. Headlee. See reports for 1913, 1914.

New York, Albany,—E. P. Felt.

Factors influencing distribution and abundance of insects. Considerable data accumulated, not much published. Begun in 1899.

Effect of applications of petroleum or petroleum compounds to dormant trees. Much published, investigations still in progress. Begun in 1911.

New York, Cornell University, Ithaca,—Glenn W. Herrick.

Insects injurious to hops in New York. I. M. Hawley in charge. Work just begun.

Insects injurious to clover. C. H. Hadley, Jr., in charge.

New York, Geneva,—P. J. Parrott, and W. J. Schoene.

Insecticidal properties of various sulphides and polysulphides.

Ohio, Wooster,—H. A. Gossard.

Relation of insects to fire-blight in orchards. Preliminary experiments during one season. Commenced in 1907.

Collect grasshoppers and mosquitoes to make a representative collection. Good collection of grasshoppers; only a beginning with mosquitoes.

Shade tree and forest insects. Observations and experimental data collected through several years. J. S. Houser, in immediate charge.

Spraying mixtures. Considerable testing with newer mixtures, especially for scale control. J. S. Houser in immediate charge.

Stored Grain Insects. Experiments with heat and moisture carried on for several years. W. H. Goodwin in immediate charge.

Spraying Machinery Studies. Illustrative types and demonstration machine sectioned to show construction. Improvements and new features. Carried on for several years. Mostly published. W. H. Goodwin in immediate charge.

Important fruit insects in the Lake Erie Fruit Belt. Two years observations. J. L. King in immediate charge.

Household insects. New developments investigated. R. D. Whitmarsh in immediate charge.

Oregon, Corvallis,—H. F. Wilson.

Insecticides and combination sprays. Begun 1912.

Pennsylvania, Harrisburg,—H. A. Surface.

Varieties of cultivated plants, especially fruits, in reference to their liability to insect and plant disease injury. Progress slow.

Improvement of the lime-sulfur solutions. Completed.

Practical dissemination of insect parasites, especially of San José scale.

Native reptiles and amphibians as enemies of insects.

South Carolina, Clemson College,—A. F. Conradi.

Relation of temperature and moisture to insect activity. Begun 1910. Progress slow.

Effect of oils on gloomy and cottony maple scales. Begun 1911. Good success.

West Virginia, Morgantown,—L. M. Peairs.

The relation of temperature to insect life. Begun in 1904 by Professor Sanderson. Satisfactory progress.

Dusting in the orchard. Sufficiently complete for preliminary report.

Dusting for truck crop insects. Fair progress.

Minor orchard insects. Determination of distribution and damage from minor pests.

Control of apple and peach borers. Considerable data. W. E. Rumsey.

Wisconsin, Madison, J. G. Sanders.

Control of onion maggot and other onion insects. Begun 1910, discontinued until 1912 and continued up to 1914.

Tobacco insects of Wisconsin. Mr. Stewart C. Chandler in charge. Begun 1914. Progress satisfactory.

Insects injurious to truck crops in Wisconsin. Neale F. Howard in charge. Begun 1914. To be continued.

Taxonomic Directory

Thysanoptera.

W. E. Hinds, Auburn, Ala., will classify for privilege of retaining duplicates and of naming and describing the new species.

Mallophaga and Anoplura.

V. L. Kellogg, Stanford University, Cal., will classify collections (under reservation as to available time) for usual privileges; especially glad to examine material from mammals.

ORTHOPTERA.

R. A. Cooley, Bozeman, Mont., will classify *Orthoptera* of the Northwest.

B. H. Walden, New Haven, Conn., will classify, in so far as other work will permit.

MEMBRACIDÆ, JASSIDÆ, CERCOPIDÆ and FULGORIDÆ.

Z. P. Metcalf, West Raleigh, N. C., will classify for permission to retain new and unusual forms for further study, and to dispose of a fair number of such forms as he may see fit.

JASSIDÆ.

E. D. Ball, Logan, Utah, will classify North American forms under the usual conditions.

APHIDIDÆ.

C. P. Gillette, Fort Collins, Colo., will classify, provided data on food plants and date and location of capture are furnished, and the privilege of retaining the specimens of special interest when there are duplicates.

H. F. Wilson, Corvallis, Oregon, will classify *Aphididæ* if data on food plants, dates and location of capture are furnished. The correct scientific name of the food plant should be given. Material in the subfamily *Lachnina* is especially desirable.

APHIDIDÆ and PSYLLIDÆ.

Edith M. Patch, Orono, Maine, will classify on receipt of mature material in good condition with record of food plant accurately determined on which the species developed.

ALEYRODIDÆ.

J. R. Watson, Gainesville, Fla.

COCCIDÆ and ALEYRODIDÆ.

W. E. Britton, New Haven, Conn., will classify in so far as other work will permit.

COCCIDÆ.

J. G. Sanders, Madison, Wis., will classify species of the genus *Lecanium*.

R. A. Cooley, Bozeman, Mont., will classify the genera *Chionaspis*, *Hemichionaspis* and *Phenacaspis* of the world.

R. H. Pettit, East Lansing, Mich., will classify in so far as other work will permit.

HETEROPTERA.

Paul S. Welch, Manhattan, Kansas, will classify, in so far as other work will permit, aquatic *Heteroptera*.

SARCOPHAGIDÆ of the U. S.

R. R. Parker, Amherst, Mass., will classify.

CHIRONOMIDÆ and MYCETOPHILIDÆ.

O. A. Johannsen, Cornell University, Ithaca, N. Y., will classify for the privilege of retaining desiderata.

MUSCOID FLIES.

Charles H. T. Townsend, U. S. National Museum, Washington, D. C., will classify as time permits. Will send names in return for specimens.

EMPIDIDÆ.

A. L. Melander, Pullman, Wash. (at the Bussey Institution, Forest Hills, Boston, Mass., until June), will determine *Empididæ* (Diptera) for the privilege of retaining desiderata.

SYRPHIDÆ.

A. L. Lovett, Corvallis, Oregon, will determine if duplicates are sent.

ITONIDIDÆ.

E. P. Felt, State Museum, Albany, N. Y., will classify provided the midges are new, from new localities or have been reared and food record is available.

MEGASTIGMUS.

C. R. Crosby, Cornell University, Ithaca, N. Y.

CHALCIDOIDEA.

A. A. Girault, Brisbane, Queensland, Australia, will classify.

BOMBIDÆ.

H. J. Franklin, East Wareham, Mass., will classify to limit of his spare time.

TENTHREDINIDÆ and UROCERIDÆ.

A. D. MacGillivray, 603 W. Michigan Ave., Urbana, Ill., will classify in so far as other work will permit for permission to retain types and specimens not present in collection.

APHIDIINÆ and OPIINÆ, sub-families of BRACONIDÆ.

A. B. Gahan, College Park, Md., will classify on condition that specimens may be retained if desired.

SPHECIDÆ, ELIDINÆ, APORINÆ, genus ICHNEUMON of N. E.

H. T. Fernald, Amherst, Mass., and assistants will classify.

ICHNEUMONIDÆ.

J. H. Merrill, Manhattan, Kansas, will classify, in so far as other work will permit *Rhyssides* of the *Ichneumonidæ.*

APOIDEA.

E. G. Titus, Logan, Utah. For permission to retain types and specimens not present in his collection.

Myron H. Swenk, Lincoln, Neb., will classify members of this group from Nebraska, and any North American member of the following genera—*Colletes*, *Nomada* and *Anthidium.*

NYMPHULINÆ.

Paul S. Welch, Manhattan, Kansas, will classify in so far as other work will permit, the family *Nymphulinae.*

MR. GLENN W. HERRICK: In regard to this report, I would like to state that if it is published together with the projects of the Bureau of Entomology, it will occupy about 46 printed pages which is nearly as many as are sometimes published in a single number of the JOURNAL OF ECONOMIC ENTOMOLOGY. The projects of the Bureau of Entomology have already been published by the Department of Agriculture and are available to the members of the Association.

After a general discussion of the feasibility of publishing the entire report in the JOURNAL, it was voted that the report as presented by the committee, which would occupy about 16 printed pages, be published in the JOURNAL, and that reference be made to the projects of the Bureau of Entomology so that the members desiring to secure printed copies of these projects could obtain them from the Department of Agriculture.

PRESIDENT H. T. FERNALD: I will now appoint the committees for the meeting:

COMMITTEE ON AUDITING: T. J. Headlee and Franklin Sherman, Jr.

Committee on Resolutions: W. C. O'Kane, C. Gordon Hewitt and George A. Dean.

Committee on Nominations: Wilmon Newell, A. L. Quaintance and C. P. Gillette.

The next order of business is the action on the proposed amendment to the by-laws.

Mr. E. P. Felt: It if is in order, I would like to substitute in the proposed amendment the words "one dollar and a half" for "two dollars," for annual dues for active members. In explanation of this I will say that at the present time all members are paying $1.00 for the Journal. Active Members pay $1.00 membership fee and Associate Members 50 cents. If we leave the by-law as it stands and continue the price of the Journal to members at $1.00, the Active Members will receive their membership and the Journal for $3.00; Associate Members for $2.00. If the subscription price of the Journal is advanced 50 cents to both members and non-members, it will mean that Active Members will pay $1.50 a year for membership fee and $1.50 a year for the Journal, while Associate Members will pay $1.00 for membership fee and $1.50 for the Journal. This arrangement will result in placing the additional funds where they are most needed.

Mr. T. J. Headlee: I would like to inquire whether this arrangement will provide ample funds for publication. I have felt that we need more money for publishing the Journal and that we ought to take care of all papers that may be presented for publication and do it rather promptly. I would like to see the Journal grow in size and serve a larger constituency.

Secretary A. F. Burgess: In answer to the question raised, I will say that if this motion prevails and the change in subscription rate is made for the Journal in accordance with the suggestion made by Mr. Felt, I think the stringency will be relieved and we will be in good financial condition. I believe we will be able to print a somewhat larger volume of matter in the Journal but this will depend on how severely our foreign subscription list is curtailed.

It was voted to adopt the amendment suggested by Mr. Felt and Article 3, Section 1, of the By-laws was adopted so that it reads as follows:

"The annual dues of Active Members shall be $1.50 and the dues of Associate Members $1.00, which shall be payable in advance. No dues shall be payable from foreign members. Annual dues shall not include subscription to the Journal of Economic Entomology."

Mr. E. P. Felt: In view of the fact that the Advisory Committee last year recommended an increase of 50 cents in the subscription price of the Journal of Economic Entomology, I move that this increase be adopted by the Association.

This motion was seconded and carried.

Secretary A. F. Burgess: In the report of the Executive Committee a suggestion was made in regard to the possibility of holding a special meeting at San Francisco next year. It appears that the Executive Committee do not think it desirable to hold the annual winter meeting there. We have a large attendance at this meeting and it would seem desirable for a committee to be appointed to consider the matter and report at the last session on the advisability of holding a summer meeting at San Francisco. I would therefore move that a committee of three be appointed to consider this matter and report at the last session.

The motion was seconded and carried.

President H. T. Fernald: I will appoint on this committee: W. E. Britton, R. A. Cooley, and E. G. Titus.

Secretary A. F. Burgess: My attention has been called to the fact that Mr. H. E. Summers is not able to attend this meeting on account of illness. He is one of our representatives on the Council of the American Association for the Advancement of Science. I would therefore move that the Chair appoint a substitute to serve in Mr. Summers' absence.

The motion was carried and the President appointed Mr. J. G. Sanders to serve in this capacity.

Mr. R. A. Cooley: As has been previously stated, Mr. Summers is seriously ill and unable to attend the meeting. I move that the Chairman appoint a committee of three to draw up a suitable telegram to forward to him expressing the sympathy of the Association and our wish that he could have attended the meeting.

The motion was seconded and carried unanimously.

The President appointed on this committee: R. A. Cooley, Herbert Osborn and Wilmon Newell.

The final business session was held Thursday, December 31.

President H. T. Fernald: We will now listen to the report of the Auditing Committee by T. J. Headlee.

December 31, 1914.

To the American Association of Economic Entomologists:

Your auditing committee has examined the accounts of the Association, of the Journal and of the Entomologists' Employment Bureau and finds them to be correct.

T. J. Headlee,
F. Sherman, Jr.,
Auditors.

On motion, the report was adopted.

President H. T. Fernald: We will now listen to the report of the Membership Committee by R. A. Cooley.

REPORT OF THE COMMITTEE ON MEMBERSHIP.

Your Committee on Membership Recommends

1. That the following named persons be elected to associate membership:

Walter S. Abbott, Vienna, Va.
Arthur J. Ackerman, Washington, D. C.
Harry W. Allen, Melrose Highlands, Mass.
Irving L. Bailey, Northboro, Mass.
Geo. W. Barber, Hyattsville, Md.
A. H. Beyer, Columbia, S. C.
M. W. Blackman, Syracuse, N. Y.
E. B. Blakeslee, Washington, D. C.
L. J. Bower, Salt Lake City, Utah.
Roy E. Campbell, Sacramento, Cal.
Thomas R. Chamberlin, Salt Lake City, Utah.
James W. Chapman, Forest Hills, Boston, Mass.
Robt. N. Chrystal, Ottawa, Canada.
C. R. Cleveland, Durham, N. H.
Geo. H. Corbett, London, England.
Harry F. Dietz, Indianapolis, Ind.
John E. Dudley, Jr., Vienna, Va.
M. W. Eddy, State College, Pa.
Wm. O. Ellis, Ithaca, N. Y.
W. T. Emery, Charlottesville, Va.
David E. Fink, Norfolk, Va.
R. J. Fiske, Washington, D. C.
F. H. Gates, Tempe, Ariz.
Hugh Glasgow, Geneva, N. Y.
John E. Graf, Whittier, Cal.
Ernst Hargreaves, So. Kensington, London, England.
Bartle T. Harvey, Colorado Springs, Colo.
Williard H. Hasey, Amherst, Mass.
Chas. C. Hill, Nashville, Tenn.
Harold R. Hogan, Logan, Utah.
A. H. Hollinger, Columbia, Mo.
N. F. Howard, Madison, Wis.
Ralph W. Howe, Tallulah, La.
John C. Hutson, Amherst, Mass.
J. L. King, Cleveland, Ohio.
Harry H. Knight, Ithaca, N. Y.
George H. Lamson, Jr., Storrs, Conn.
Walter H. Larrimer, Wellington, Kansas.
Edgar M. Ledyard, Berkeley, Cal.
Mortimer F. Leonard, Ithaca, N. Y.
Clifton W. Loveland, Providence, R. I.
James F. Martin, Amherst, Mass.
Frank L. McDonough, Batesburg, S. C.
Geo. B. Merrill, Aibonito, P. R.
Philip B. Miles, Salt Lake City, Utah.
Wm. Moore, St. Paul, Minn.
Wilfred A. Osgood, Durham, N. H.
C. M. Packard, Wellington, Kansas.
Frank C. Pellett, Atlantic, Iowa.
W. E. Pennington, Hagerstown, Md.
C. H. Richardson, New Brunswick, N. J.
Lawrence P. Rockwood, Salt Lake City, Utah.
Ernest E. Scholl, Austin, Texas.
E. W. Scott, Vienna, Va.
E. H. Seigler, Washington, D. C.
Sterling J. Snow, Salt Lake City, Utah.
E. H. Strickland, Ottawa, Canada.
Frank L. Thomas, Athol, Mass.
Chester F. Turner, Greenwood, Miss.
Jos. S. Wade, Wellington, Kansas.
Carrington B. Williams, Merton, Surrey, England.
Taylor S. Wilson, Wellington, Kansas.
Francis Windle, West Chester, Pa.
William C. Woods, Ithaca, N. Y.
Max P. Zappe, New Haven, Conn.

2. That the following named persons be transferred from Associate to Active Membership:

J. M. Aldrich, Bureau of Entomology, Lafayette, Ind.
E. W. Berger, University of Florida, Gainesville, Fla.
Lawson Caesar, Provincial Entomologist, Guelph, Ont., Canada.
H. E. Hodgkiss, N. Y. Experiment Station, Geneva, N. Y.
C. W. Howard, Minn. Exp. Sta., Univ. Farm, St. Paul, Minn.
P. H. Timberlake, Bureau of Entomology, Salt Lake City, Utah.
Geo. P. Weldon, California Board of Horticulture, Sacramento, Cal.

3. The Committee recommends that the following resignations be accepted:

A. B. Cordley, Corvallis, Oregon (Active).
J. C. Gifford, Cocoanut Grove, Fla. (Associate).
R. S. Mackintoch, St. Paul, Minn. (Associate).

4. The Committee recommends that the Secretary be instructed to notify five active members and six associate members who are in arrears for dues for two years, and two associate members who were elected last year and have not paid their first year's dues, that if such dues are not paid within three months their names will be dropped from the roll.

5. The Committee recommends that the Secretary be instructed to remit membership dues to Mr. Theodore Pergande, Washington, D. C., and retain his name on the roll.

6. The Committee desires to submit the following:

That the establishment of genuine departments of research by manufacturers of insecticides or by other similar organizations is to be highly commended, especially when the arrangements therefor take the form of endowment of research fellowships, thereby placing such work under the immediate direction of college or experiment station authorities; but in such cases, membership in this association, active or associate, should inevitably indicate disinterested and scientific investigation in applied entomology.

R. A. Cooley,
Wilmon Newell,
W. C. O'Kane,
Membership Committee.

On motion, the report was adopted.

President H. T. Fernald: We will now listen to the report of the Committee on Resolutions.

REPORT OF COMMITTEE ON RESOLUTIONS

Your Committee Submits the Following:

I. The Association desires to express to Dr. Henry Skinner, Dr. Philip Calvert and all other local entomologists, and to the University of Pennsylvania, its hearty gratitude for their cordial hospitality and for the admirable facilities provided by them for the association meetings. It desires to thank also the members of the Veterinary Faculty who have given their personal services at the sessions of the association.

II. The Association desires to place on record its deep appreciation of the work of The Imperial Bureau of Entomology of London, England, in the direction of disseminating through "The Review of Applied Entomology" information regarding the occurrence and control of insect pests in foreign countries, which information the members of the Association have found to be of very great value in their work on this continent.

III. The Association affirms its unalterable opposition to any tendency toward merging the identity of economic or applied entomology with that of plant pathology, under the term phytopathology, or other indirectly related but distinct branches of applied science; in the belief that such merging is without foundation in logic, utility or necessity.

W. C. O'Kane,
C. Gordon Hewitt,
Geo. A. Dean,
Committee.

By vote of the Association, the report was accepted.

President H. T. Fernald: We will now listen to the Committee on Bibliography by E. P. Felt.

REPORT OF THE COMMITTEE ON THE PUBLICATION OF THE BIBLIOGRAPHY OF AMERICAN ECONOMIC ENTOMOLOGY

Although the Committee was authorized by virtue of the action taken at the last meeting, to proceed with the preparation and publication of this bibliography, it was deemed wise to submit the project to the Federal authorities in a more formal manner. After some preliminary correspondence and investigation, a communication emphasizing the usefulness of the bibliography, outlining a plan for its preparation and strongly urging its issuance by the United States Department of Agriculture was forwarded to Dr. L. O. Howard, Chief of the Bureau of Entomology, who kindly transmitted it together with a recommendation that the plan as outlined by your Committee be adopted, to Dr. William A. Taylor, Chairman of the Committee on Publications of the Department of Agriculture. This latter Committee, under date of November 20 last, went on record as being fully impressed with the usefulness of this publication to working entomologists and as of the opinion that it should be published, but in view of the precedent which would be established by the resumption of its publication, could not recommend that it be published by the Department and the Committee therefore respectfully recommended that it be not approved for publication.

Your Committee, after consultation with Mr. Nathan Banks of the Federal Bureau of Entomology, recommends that this work take the form of an index of American literature for the decade ending with this year. A comprehensive and detailed plan has been adopted. It is estimated that the index will make a publication of from 100 to 125 pages which can be sold at approximately two dollars a copy.

Dr. L. O. Howard has kindly agreed to detail a man for the compilation of the index, and under the conditions obtaining, your Committee recommends that the preparation of the work be begun at once, and in the event of its being impossible to find any other satisfactory publishing agency, that the American Association of Economic Entomologists issue the index in accordance with the plan outlined in the report which was submitted and favorably acted upon at the Atlanta meeting.

Respectfully submitted,

E. P. Felt,
W. D. Hinds,
W. C. O'Kane,
W. E. Britton,
A. F. Burgess,
Committee.

Mr. E. P. Felt: I want to state that it has taken nearly a year to exhaust every reasonable resource to secure the Publication of the Bibliography by the United States Department of Agriculture. The vote taken at the last meeting provided that if other means could not be found for publishing the Bibliography that it be undertaken by the Association and the report that has just been presented, commits the Association to publish the Bibliography in case no other means of publication can be secured.

Mr. Wilmon Newell: I wish to say that I think the Association owes this Committee a debt of thanks for the effort which they have made to secure the preparation and publication of this Bibliography as it will be a great help to all entomologists.

Mr. W. E. Britton: The plans suggested by the Committee differ slightly from that followed in preparing the Bibliographies that were published some years ago. The idea is to prepare it more as a bibliographical index. It will take up less space and the Committee believes be more useful to the entomologists than the former publications.

By vote of the Association, the report was adopted, and the Committee continued.

President H. T. Fernald: Next in order is the nomination of Journal officers by the Advisory Board.

Mr. Wilmon Newell: The Advisory Board of the Journal of Economic Entomology nominates the following officers for the ensuing year:

Editor, E. P. Felt.
Associate Editor, W. E. Britton.
Business Manager, A. F. Burgess.

By motion the report of the committee was adopted.

President H. T. Fernald: We will now listen to the report of the Committee on Nominations.

Mr. Wilmon Newell: The Committee has found itself in a very perplexing situation, with a great deal of valuable material to choose from, so that its main regret is that several presidents could not be chosen and several additional vice-presidents. The Committee nominates for:

President, Glenn W. Herrick.
First Vice-President, R. A. Cooley.
Second Vice-President, W. E. Rumsey.
Third Vice-President, E. F. Phillips.
Secretary, A. F. Burgess.
Member of the Committee on Nomenclature, Herbert Osborn.
Member of the Committee on Entomological Investigations, E. G. Titus.
Member of the Committee on Membership, J. G. Sanders.
Councilors to the American Association for the Advancement of Science, S. A. Forbes and C. L. Marlatt.
Director of Employment Bureau, W. E. Hinds.
Members of Advisory Board of the Journal of Economic Entomology, F. M. Webster and P. J. Parrott.

By vote of the Association, the Chairman was instructed to cast a ballot for the officers nominated by the Committee. A ballot was cast and the above-mentioned officers were declared elected.

President H. T. Fernald: Is there any miscellaneous business to be acted upon at this time?

Mr. T. J. Headlee: I have been interested in examining the list of Associate and Active members and it seems to me that there are some men on our Associate list who should be promoted to Active Membership, and I would be very glad to see the Committee next year adopt the policy of promoting more Associate Members to the Active list.

Secretary A. F. Burgess: I would like to call attention to the report of the Membership Committee which was adopted by the Association last year. The first section of that report reads as follows:

"that in the case of Active members desiring to nominate Associate members for Active membership, they shall file such nominations with the Chairman of the Committee on Membership at least three months prior to the annual meeting. Such nominations shall be accompanied by full information concerning the nominees' publications and other qualifications."

I wonder how many such statements were filed with the Committee on Membership three months prior to the time of this meeting. I am not speaking for the Committee on Membership but from the relations which I have had with the members, I know that they have an immense amount of work to do. They can do it more thoroughly and better if they have ample time. I have read this section of the report of last year while many members are present so that during the coming year those who know of Associate members who should be promoted, will take the matter up in time and give the Membership Committee a fair chance to consider each case.

Mr. R. A. Cooley: I have been on the Membership Committee for three years and I know that it is the wish of that Committee to follow strictly the desires of the Association in regard to recommendations concerning membership. It has come to my attention a number of times that members of the Association were not fully informed as to the limits set by the constitution on Active Membership, and also of the resolutions which have been adopted by the Association from time to time for the guidance of the Membership Committee. The Membership Committee has a difficult task to perform but I know it will welcome suggestions from the members of the Association.

President H. T. Fernald: The Chairman has found it somewhat unpleasant on his part to be obliged to enforce the time limit on members who have presented papers. Our rules limit the time for a paper to 15 minutes and it is the custom to consider the amount of time requested by a member when presenting his title as the maximum that he will need. If the rules had not been rigidly enforced at this

meeting, I fear we would not have been able to complete our program. I would suggest therefore that it will make it much easier for the presiding officer next year if members will estimate more closely the amount of time which they need to present their papers. I would also call attention to the reference already made in the report of the Executive Committee to the preparation of an official seal for the Association. I am sure the new officers will be very glad to receive suggestions in regard to a proper design for a seal.

Mr. R. A. Cooley: The Membership Committee have found it difficult to consult the constitution and by-laws of the Association owing to the fact that a number of amendments have been made from time to time since the constitution was printed. I would therefore move that the Secretary be authorized to have the constitution and by-laws printed in the Journal during the coming year.

By vote of the Association, the motion was carried and the Secretary so instructed.

Mr. R. A. Cooley: I wish to report that the committee appointed to send a telegram to Mr. Summers has done so, extending the greetings of the Association and its wishes for his speedy recovery.

Mr. C. Gordon Hewitt: I move that the Association extend a very hearty vote of thanks to our President and Secretary, who have carried on this meeting with such expedition and in such a satisfactory manner. We all appreciate the difficulties which the President mentioned in regard to keeping us within time limits, and I am sure that his efforts have been very satisfactory and that we have not suffered in any degree from the President's very necessary rulings.

By vote of the Association the motion was adopted.

President H. T. Fernald: I am sure that the President and Secretary both appreciate the kind feelings which you have indicated in this way.

We will now listen to the report of the committee on the next meeting by W. E. Britton.

REPORT OF COMMITTEE ON MEETINGS

Your committee has conferred with a number of members present and all agree that a meeting next year in California should not in any way take the place of our regular winter meeting. Undoubtedly an extra summer meeting for field excursions, papers and discussions would be desirable; it would give western entomologists a meeting in their part of the country; it would afford an opportunity for eastern men to visit the Pacific Coast, survey the conditions there and at the same time meet with their brother workers; a general round-up for interchange of thought and opinion would surely be a benefit to those in attendance and to economic entomology in America.

Your committee, therefore, recommends that the Executive Committee of this Association be authorized to arrange such a meeting for the summer of 1915; that

the Association hold its next annual meeting in affiliation with the American Association for the advancement of science, and that all arrangements for this meeting be referred to the Executive Committee with power to act.

W. E. Britton,
R. A. Cooley,
E. G. Titus,
Committee.

By a vote of the Association, the report was accepted and recommendations adopted.

Mr. E. G. Titus: Inasmuch as there will be a western meeting next summer, I wish in behalf of the entomologists of Utah to invite any members going west to stop at Salt Lake City. If you will advise us when you are coming, we will endeavor to meet you. There are a number of entomologists in that city and they will all be glad to receive you.

Mr. R. A. Cooley: I wish to say that in going to California, you can pass through Montana by travelling on the Northern Pacific Railroad. We would certainly be delighted to receive you in Montana and show you every courtesy.

Mr. C. Gordon Hewitt: I should like to add to the remarks of the last speakers that the Canadian Pacific also offers a delightful and interesting route to the West. We would be pleased to entertain any members who may be going that way.

Mr. George A. Dean: Inasmuch as so many have given glowing invitations, I would like to call attention to the fact that we in Kansas are right in the center of the United States, and that it is a good place to break the long journey. We can't give you anything to drink out there except water, but we can assure you of a hearty welcome at Manhattan, right on the main line of the Rock Island and the Union Pacific.

Mr. Wilmon Newell: In connection with the invitations already presented, permit me to say that there are some people of good taste and refinement that occasionally take the southern route to California, and I would go farther and in the language of a New Orleans restaurant, would say that "If you would see and be seen by people of prominence, take the southern route," and we would be more than glad to welcome you and give you consideration for entomological and gastronomical things. (Applause.)

President H. T. Fernald: If there is no other business, I hereby declare the twenty-seventh annual meeting of the Association adjourned.

PART II PAPERS AND DISCUSSIONS

President H. T. Fernald: I will ask first Vice-president Herrick to take the chair.

Vice-President Herrick: We will listen to the annual address of the President.

SOME PRESENT NEEDS IN ECONOMIC ENTOMOLOGY

By H. T. Fernald, *Amherst, Mass.*

The wonderful progress of economic entomology during the past half century in this country, and more recently in other lands, has to a large extent, after all, been pioneer work and the farther exploration has advanced, the broader the territory has been found to be. Who foresaw at the time of Dr. Riley's first presidential address in 1890, that twenty years later entomologists would be studying pellagra, typhoid, and other diseases to determine the relation insects bear to them, or that the importation of parasites and the study of insect diseases would perhaps lead to successful methods of control? A few of those having the broadest vision perhaps, but only a few. Today if we examine the fields of investigation awaiting the worker no limits seem in sight, and each year to come is liable to bring with it the first steps in paths hitherto untrodden.

Stated briefly, the present needs of the economic entomologist appear to group themselves under two main heads. These are: first, more complete and accurate investigation of subjects which have already been more or less studied; and second, the investigation of new territory; while correlated with both are certain needs which are necessary to the successful prosecution of either. To consider some of the subjects under these heads is my purpose today.

It has been said that we do not know everything which should be known about even one insect. I well remember that when the book on the gypsy moth appeared in 1896 someone remarked—I think at one of these meetings—that it was the nearest to a monograph of an insect which had ever appeared. But if we examine the wonderful contributions to the life, habits, enemies and methods of control of this pest which have since appeared, it becomes at once evident how far it fell short of being what it was supposed to be. Since the appearance of that book the labors of State and United States workers have probably doubled our knowledge of this insect, and still there is much more awaiting discovery.

If this be true, how much more is it true of many others of our most common pests. How much uncertainty is to be found with reference to the fall brood of the army worm—what method of spraying is the best to use for the codling moth—how may we best attack the species of white grub, wire worms, etc.? But it is unnecessary to multiply examples. They will occur in too large numbers to all.

First, then, let me make a plea for more exhaustive studies of the life histories of even our most common pests. Some small, apparently unimportant point, perhaps already partly revealed, may on investigation prove the key to a new and successful method of control or at least solve some perplexing point. Thus the discovery of aerostatic hairs in young gypsy moth larvæ has provided a possible explanation for the appearance of colonies in unexpected places and has pointed out the necessity for close watching far beyond limits of continuous distribution, to discover and suppress such colonies before they have become so large as to make this impossible.

After all, we have thus far been merely skimming the surface in this part of our work and among other things not the least important is a thorough knowledge of the lives of our insect foes.

What has just been said also holds good for another class of insects—those which though ordinarily not injurious may at some time become so. When the saddled prominent (*Heterocampa guttivitta* Walker) suddenly appeared in destructive abundance a few years ago, the entomological workers in the region attacked were seriously handicapped by the fact that practically no information about this insect was available, and their time was taken, less by giving advice what treatment to use, than in finding this out for themselves. Of course, this could not have been avoided, but nevertheless careful studies of insects not ordinarily destructive may at almost any time become of extreme value.

Another subject which needs much more investigation, is that of insecticides. Just as quinine was empirically known as a treatment for malaria long before the cause of the disease was known, so are a number of insecticides used in treatment, with no definite knowlege as to the nature of their action or of their effect on plants. A thorough study of various materials, both among stomach poisons and contact insecticides, to determine their effect on insects, the way in which they may be best applied, their action if any, on plant tissue, the range limits of safety in strength for application, and variation in any of these points under varying conditions of light, temperature, humidity and other conditions, should be made with care if we are to learn how and when to apply insecticides with entire confidence in the results. New stomach poisons are undoubtedly awaiting discovery, yet until within the last

half dozen years the possibility that anything but arsenic could be used does not seem to have occurred to most workers. The work of Maxwell-Lefroy along this line in India deserves mention here because of its pioneer nature.

When on the same day two peach orchards, one in Northern Ohio and the other in Virginia, are sprayed with the same material at the same strength, and apparently under practically the same conditions, and one orchard is severely injured while the other escapes, it is time for a critical study of all the factors concerned in spraying.

And here I must make a statement which will seem very academic in its nature. In research experimentation in almost every case a large number of factors are involved. Frequently these are light, temperature, humidity, composition and variations in composition of the material used, time of year, etc. If we are to obtain positive and conclusive results from our experiments we must take into account every factor which may possibly be concerned, and run a series of experiments in which only one factor shall vary, the others remaining fixed. This, of course, means a complete series for each factor involved, in combination with every variation of every other factor. Such experiments take time—often many years—to produce complete results, but the necessity for conducting them in this way if the conclusions reached are to be relied upon, should be self-evident. Yet a careful analysis of many of the experiments, the results of which have been published during the last decade, shows that in some cases three, four or even more of the factors which might influence the results have been allowed to vary at the same time. Under such conditions as these I claim that the principle just advanced, even though acknowledgedly academic, is being so largely ignored that attention should be called to it, and that work done without due care should receive only such fractional credit as it deserves, without acceptance as a final dictum.

Some of those present today listened last year to a magnificent presentation of the methods used in the investigation of pellagra in the South. Several afterwards remarked that such thoroughly systematized and comprehensive studies could only be carried out with the resources and staff which the Government alone could supply. But if this should be true (and I doubt it), this is no reason why such work as is attempted should not be prosecuted in accord with the simplest principles of inductive logic, as far as it goes, resulting at least in reliable records of the ground actually covered.

The "bug versus bug" doctrine which has been so actively promulgated in various parts of the country is a most attractive one. It appeals to the legislator, to the farmer, and to the business man as a natural and logical method for the control of our increasing insect

enemies, and it is probable that appropriations for investigations in this subject can be more easily obtained than for any other form of entomological work. Much has been done along this line, particularly by the United States Department of Agriculture, and many striking results have been obtained. If, however, a supposed parasite when imported and liberated should prove to be a secondary parasite, much of the benefit of the entire work might be lost, thus emphasizing what has already been said as to the necessity of a thorough knowledge of the life history and habits of every insect. The introduction of parasites will undoubtedly prove an extremely important part of the work in economic entomology in the future, but it must be conducted only by the most competent persons and after a thorough knowledge as to what will happen thereafter in each case.

An examination of the list of subjects under investigation, given in the JOURNAL OF ECONOMIC ENTOMOLOGY, suggests one or two points of interest to consider for a moment. One of these is—How many subjects can be completely worked out by one man who feels the pressure for publication behind him all the time? It seems likely that this pressure must often result in premature and imperfect publications, liable to give misleading impressions. A few years ago, at one Experiment Station at least, the director would sometimes inquire whether the entomologist of that station ever intended to get out a bulletin. Under such conditions one cannot expect the best work, but instead the production of hastily prepared and fragmentary papers. Another thought developed by an examination of the list is that to make satisfactory progress on all the projects named, in same cases, the investigator must be working twenty-four hours per day, seven days each week. Such pressure as this can only lead to an impairing of the quality of the work done, and it would seem wiser to attempt fewer projects and thus obtain more complete and satisfactory results.

Many other topics might be legitimately touched upon here, but time will not permit. I therefore turn to the second division of my subject; viz., the investigation of new territory.

Under this head there are undoubtedly many surprises in store for us. The gates to several new fields of entomological knowledge have recently been discovered and are now standing ajar, giving us glimpses of what may come. One of these is the field of medical entomology, and the presidential address before this Association two years ago ably pointed out the progress which has already been made in that line.

To mention some other topics which promise rich returns to the investigator is a dangerous task, for in the time available it is impossible to even name them all, and to touch on only a few would seem

to be making invidious distinctions. Yet to everyone, certain subjects appeal more strongly than others, and on this basis of personal interest alone, a few which have for one reason or another appealed strongly to the speaker, may be referred to briefly.

The researches of Bachmetjew upon the temperature relations in insects, followed by those of others who have applied his discoveries to the preservation of life during the winter—investigations in which Sanderson and others have been active in this country—are full of significance. Closely connected to this have been the studies of the relation of temperature to development, one paper on which was presented at the last meeting of this Association. It is my belief that work along these lines has only just been begun, and that the results will prove of great importance, not only to pure science but to economic entomology.

Another field which promises to contain much of great value is that of the relation of food to reproductive activity and to longevity. Though thus far investigated mainly with reference to parasites, it would seem to be of importance everywhere, and the subject deserves far more extended exploration.

The subject insecticides has already been referred to, but how little we really know as to the way in which some of them actually kill insects has been most interestingly shown by Shafer. More work in this field is waiting, and results of an importance which cannot yet be estimated are sure to come.

Whether it is possible by methods of plant breeding to produce varieties having greater freedom from the attacks of insects than those now in use, is a field which so far as I know has not yet even been seriously considered. The only cases which occur to me are the recommendation to select varieties of wheat which "tiller" freely, as a means of saving wheat fields liable to attack by the Hessian Fly, and the unfortunate one where two New Jersey nurseries apparently spread the San José Scale over the country in their attempts to find a Curculio-proof plum, and even those do not come strictly under the head of actual plant breeding. Whether this field will prove productive no one can tell at present, and actual exploration will be necessary to determine whether it is to be of any value.

The sensation produced by the appearance of a bulletin a few years ago upon the arsenical poisoning of fruit trees by spraying is still well remembered by us all. Here was a new field for exploration and a number of workers have now attacked this subject. Whatever the final conclusions reached may be, more information along this line is necessary, and it may be permissible to suggest that a knowledge of what "thou shalt not" do in entomology is ofttimes as valuable as knowledge in its positive form.

Insect outbreaks and their causes are as yet entirely without explanation except in such general terms as to leave us as uncertain when to expect them and how to prevent or prepare to meet them as before. We guess they may be due to climatic conditions beyond our control or perhaps to an unusual absence of the natural enemies of the insects concerned. I find practically no evidence on the subject, however, and if climatic conditions are involved we lack any knowledge as to what these are. We need pioneers to explore this field and can only hope that some day, even if they cannot tell us how to prevent the outbreaks, they may discover the principles involved and be able to warn us of those soon to come. When the entomologist can publish a notice that the army worm, for example, will appear in destructive abundance the coming summer, based on anything like definite certainty, we may consider ourselves as having made a long forward step in the progress of the science to which we are devoting our lives. Whether this can ever become possible is after all aside from the point. We must explore the field and find out. Personally, taking the progress of entomology in the past as a criterion, I believe the time will come when the causes of outbreaks will be thoroughly understood and their times predicted with nearly as great accuracy as is now done for the weather.

The possibility of the successful introduction and spread of insect diseases through the agency of man has been given some attention for quite a long time. Thus far the results can hardly be called encouraging, for though disease is often very effective, man's relation to it appears to have been quite unimportant, the factors determining success seemingly having been beyond his control. Whether this will always be the case, or whether the introduction of new methods of work and distribution may place this field in the list of those which can be profitably tilled, can only be learned by further research. It is to be hoped, therefore, that workers in this line may continue their investigations until its possibilities have been fully demonstrated.

Factors which influence the distribution of animals and plants have been given considerable attention by zoölogists and botanists, at least since the appearance of Wallace's two classic volumes on "The Geographical Distribution of Animals." In all the literature on this subject, however, little consideration has been given to insects. Passing references, allusions to the presence of different forms in the different life zones, and general statements make up the bulk of published information about insects in this field. So far as I can learn, no argument bearing on crop raising has ever been provided from this source of information. The publications of the Bureau of Biological Survey list the mammals, birds and other vertebrates, and the plants of the

zones; and shells have occasionally been studied from this standpoint. Yet particularly within certain areas insects are of great assistance in indicating zone limits, and the only data available for study are faunal lists, in which too often the exact localities of capture and the elevation are unrecorded. We generally even lack a knowledge which zone a given insect particularly belongs to.

Of course, many insects are so hardy and have such powers of flight that they cannot be taken into consideration as evidence. Many others, however, provide us with important information if we only know how to use it.

It may seem almost outside the realm of entomology or at least economic entomology to be concerned with distribution except in the most general way, and it is true that in a number of states—perhaps a great many—all kinds of insects present at all are liable to be found anywhere in the state where their necessary food occurs. In many other states, however, this is far from being the case and the determination of the zonal limits in those states as indicated by the insects and supported by other animals and by plants, can lead to modifications in the crops raised, with direct benefit to agriculture.

To illustrate this by the conditions found in Massachusetts: This state is generally considered as being mainly in the Transition Zone, barely touched at one or two points on the south by the upper Austral and on the north by the Boreal. A study of distribution shows, however, that the entire southeastern portion of the state, the Connecticut Valley and two other inlets from the south are inhabited by upper Austral forms to a greater or less degree, while quite an area in the western end of the state and spots near its northern boundary have many Boreal forms.

Knowledge of this of itself, meant but little at first. But when the elm-leaf beetle had become well established, it was finally discovered that while it was a serious pest in the upper Austral sections and frequently of some importance in the Transition Zone, it was never sufficiently destructive in the Boreal areas to make treatment necessary.

The elms of Massachusetts are one of her chief attractions, shading her streets by their high arches, and growing to perfection. Their value has in some cases been fixed at five hundred dollars per tree, and nearly every town has thousands of them. Spraying for the elm-leaf beetle is almost universal in the state and an expenditure of from five hundred to twenty-five hundred dollars for this purpose each year is anticipated as a part of almost every town financial budget. Accordingly, when it was discovered that elms growing in the Boreal region need not be sprayed, thus saving that much expenditure to the towns concerned, the value of a knowledge of the zonal areas at once assumed an economic importance heretofore unrecognized.

But another surprise was yet in store. An inquiry from the shore in Southeastern Massachusetts about a burrowing insect attacking persons out berrying in midsummer led to the discovery that this trouble was caused by the larva of a mite, and attention was at once directed to the southern "jigger" and an attempt was made to ascertain the northern distribution limits of this Acarid. The data were decidedly meagre, but the southern shore of Lake Erie and somewhere along the New Jersey coast were the most northern points from which reports of attacks either by the jigger or some other similarly acting pest were received. A scrutiny of records of mammals, birds, plants, etc., captured in Southeastern Massachusetts was then undertaken to see if it would throw any light upon the conditions existing in that region, and as no collections of insects of any extent seemed to have been made there, it was planned to take up the subject by spending time in that territory for the distinct purpose of collecting.

The results thus far have been most interesting though not entirely conclusive. Numerous mammals, birds and reptiles abundant farther south but not found north of New York or even Central New Jersey occur here. Numerous southern plants not recorded from elsewhere in New England are found on Nantucket where the flora has received particular attention, and some are present on the mainland. The insect collections support the view that this part of the state has a decidedly southern aspect, and taken all together we find a strip here that is not only upper Austral but to some extent, lower Austral as well. Meteorological observations show that this portion of the state in many regards has summers comparable with those much farther south and that the winters are usually mild as compared with those only a few miles farther north, and some theory to explain these facts is, of course, in order.

An examination of the records of the United States Fish Commission, which has for many years maintained a station at Woods Hole in this district has thrown some light on this subject. According to most of our maps the Gulf Stream on its way north apparently leaves any close proximity to our coast about at Cape Hatteras, swinging strongly to the northeast. The observations of the United States Coast Survey and Fish Commission, however, show that this is not entirely correct. A study of water temperatures during a series of years indicates that the real western margin of the Gulf Stream is found not very far east of Nantucket, and also that it varies, in some years being much closer to the land than at others. Occasionally, indeed, it comes so near the land that southern floating animals such as the Portuguese Man-of-War are swept up Vineyard Sound, inside the islands, in the current, and other forms belonging much farther south may be brought in the same way.

It has been suggested that the strength and direction of the wind influence the fluctuation of the Gulf Stream, perhaps begun by an unusual strength of the southeast trade winds and their extension farther north than is usually the case. Whatever the cause may be, however, the fact remains that the Gulf Stream swings in and out, its western edge sometimes remaining near the coast for a number of years, and with this demonstrated we have a satisfactory basis for the theory that southern forms may from time to time be brought to the southeastern shores of Massachusetts in this current, thus accounting for their occurrence there. It also offers an explanation for their continued presence, for the near proximity of such a large body of warm water must naturally affect the climate of that part of the state, making it inhabitable for forms normally found much farther south.

Occasionally a severe winter, particularly when the oscillation of the Gulf Stream is eastward, must result in the destruction of many of these transplanted forms, but with the return of the Stream to its more westerly course the reëstablishment of such animals and plants as may be caught in this current and can survive the journey is likely to occur.

The practical application of these facts to agriculture comes in their bearing on the possibility of raising southern crops in the territory affected. With a summer thus lengthened, and warmer than in most of the state, the possibility of making use of these conditions to advantage presents itself, limited only by the nature of the soil and factors which aside from seasonal features require consideration.

A little work along this line has already been begun in an experimental way, and it has been found that sweet potatoes and peanuts can be raised on Cape Cod under the usual conditions there. Cotton might possibly be grown also, if the proper soil conditions could be found, but this has not been tried. The greatest value thus far resulting from the facts just presented is the realization that crops can be planted late, to supply the markets after the main season is over, without danger of their loss by early frost, and this is now being taken advantage of.

The conditions in Massachusetts have been dwelt upon at some length, because of familiarity with them; that life zones play a part, to some extent at least, in many other states is certain. The possibility of taking advantage of them is something which deserves consideration, and even if no direct economic result is obtained, a knowledge of the distribution of insects in the zones will be a great and useful addition to entomology as a whole.

Another present need of economic entomologists is a better knowledge of foreign insects. Modern transportation facilities have ren-

dered easy the introduction of the pests of other countries, and in spite of all the laws, supervisory boards and inspectors now actively at work, some of these pests at least are sure to slip in. To recognize these in their different stages and to know what steps to take for their control as soon as they appear are points becoming more important each day, and any information which can be obtained on this subject would be welcomed by every entomologist. It is to be hoped that specialists connected with the Department of Agriculture may before long find it possible to prepare a bulletin in which the worst pests of foreign lands liable to reach and establish themselves here may be dealt with in detail, and that illustrations of the different stages of these insects may be given to aid in their recognition.

The nun moth, to take a particular case, is regarded as a serious pest in Europe. When we consider the often difficult conditions under which our inspectors of imported nursery stock work: in places poorly lighted, or as night comes on; with work enough often for three men, and only one to do it; with plants so dense that it is often impossible to get at every part; with earth at the roots, which should not be removed: and too often also, with only a most general idea of what may possibly be found; under such conditions as these, we can hardly be surprised if some day the nun moth may escape observation, and before discovery, establish itself in this country, and what is true of this insect is true of many others. Sooner or later then, the American entomologist must to some degree become a world entomologist and the sooner his training covers this broader field, the better, for in the opinion of the speaker, the time must ultimately come when in spite of laws and inspections the pests of one country will become the pests of all others except where climate, lack of food, or other natural conditions operate to prevent it.

Whatever line the economic entomologist may pursue, it is evident that to reach the best results, more thorough work will be required. The study of a pest without finding a satisfactory method of control means either that the investigation was not complete, or else that our knowledge of control methods is defective. Frequently both are true. To obtain results of the kind desired, more careful and thorough—I may say monographic—work will be necessary. For this a natural aptitude, coupled with thorough training are essential to the worker, and in the long run the great results will be mainly achieved by men of this type. Persistence, attention to details, not knowing when at any moment one of the smallest of these may provide a solution of the problem, an active, inductive mind, and extreme patience in working are factors essential to success.

But whatever the work may be, when success has been attained,

the problem of publication almost always presents itself as the last and often by no means the easiest one to solve. Brief papers are fairly well taken care of now by the various entomological journals, but the best work of the future is liable to become more and more comprehensive in its nature, and for contributions of this kind there are few opportunities for publication. One crying need in economic entomology at the present time is a place where the results of extended research can be published in full. An entomological Journal on the plan of the *Journal of Morphology* would greatly help in relieving this condition, though like that journal it is probable that within a short time papers might be delayed a year or more before publication. Even then, such a magazine would be of great assistance, and with sufficient funds to permit of the frequent publications of numbers, the problem would be solved at least for the most part. Such a publication, however, would probably never pay for its cost and the problem of publication accordingly becomes one of financing. Where is the man who will establish a publication fund, or the organized body which will make a supporting grant, for this purpose? When this question has been answered one of the most important present problems of economic entomology will have been solved.

Vice-President Herrick: We have listened to this exceedingly suggestive address by the President. It is customary to defer discussion until the next session.

President H. T. Fernald: The first paper on the program will be presented by T. J. Headlee.

THE CONTROL OF MOSQUITOES IN A LIMITED LOCALITY

By Thomas J. Headlee, Ph.D., *New Brunswick, N. J.*

Introduction

Adequate consideration of the problem of controlling mosquitoes in a limited locality involves a careful study of the nature of the breeding places within the proposed limits and an almost equally careful examination of the environs of the area to be protected. Conditions may be found within the area or in the territory surrounding it which will prevent successful work except at prohibitive cost. Any person, corporation, or municipality planning to take up anti-mosquito work should, therefore, have the territory to be protected and its environs carefully studied to see whether effective work can be done at a figure which he or it is willing to pay.

For the past three years two counties in New Jersey have been trying to control the mosquitoes within their limits. For the past two years two other counties have been engaged in similar work. Three of these counties—two of which have been working three, and one, two years—are sufficiently alike in their internal and external conditions to render a comparison of their methods and results of value. For purposes of discussion, they will be referred to as counties A, B, and C.

Description of the Counties

County A consists of two rather narrow parallel ridges of high ground that run northeastward—one on each side of the Hackensack River Valley. The eastern ridge extends southwestward along the head of Newark Bay to the Kill-von-Kull; and New York Bay and the Hudson River wash its eastern base line. The ridges are rather well drained but include between them more than 11,000 acres of salt marsh, nearly all of which, before ditching, bred salt marsh mosquitoes at some time in the season. The entire area of the county amounts to about 60.48 square miles of which 17.29 are tidal marsh and sparsely inhabited. A population of 572,172 people is concentrated on these two ridges with the great majority on the eastern one. To the north of this county lie the 8,378 acres of salt marsh of the upper course of the Hackensack River and its tributaries. To the southwest lie the 8,000 acres of salt marsh along the northern, western and southern shores of Newark Bay and to the southward the salt marshes of Staten Island.

County B consists of a greatly rolling surface rising from the salt marsh on the northern and western sides of Newark Bay. As one proceeds northwestward, the ground rises and becomes rougher until the hills merge into low mountains. The 554,069 people are largely concentrated in the southeastern section in the city of Newark, but to the north and westward of Newark the area is also thickly populated. Of the 129.72 square miles of surface, a little more than 7 are salt marsh. All of this salt marsh is found along the eastern and northeastern boundary between the high land and Newark Bay. County B lies within reach of the 19,846 acres of Hackensack Valley salt marsh, the marshes of Staten Island, and the 4,000 acres of County C.

County C surface is much like that of County B but a large portion is level lying. It begins as a 4,000 acre salt marsh north and westward of Newark Bay and the Arthur Kill, and rises gently to the low mountains along its western and northern edge. Its entire surface includes 104.94 square miles. The population is generally distributed, the largest city, Elizabeth, showing in 1912 a population of 78,500.

To a certain extent this county lies within reach of the Hackensack Valley, Staten Island, and Newark Bay salt marshes.

At this point it should be said that, with the exception of the 8,378 acres of salt marsh along the upper courses of the Hackensack, an effort has been made to drain all these salt marshes, and that only to a minor extent do the mosquitoes bred on this exception trouble counties A, B and C.

The Work of Control

Inasmuch as the plan of organizing a mosquito fighting machine has already been briefly described to this Association, it is sufficient to say that the work of control naturally divides into administration (the management of the work), inspection (the finding of the breeding places), and elimination (the destruction of breeding places). Necessary to all three phases is the equipment (tools and apparatus), and education (acquainting the people with the nature and progress of the work).

Administration

Under the head of administration is included the necessary expenses of the commissioners, and the salary and expenses of the chief inspector and of his deputies, and of the necessary clerical force. The expenses of the commissioners are small or none. The number of deputies and the size of the clerical force are variable. County A has no deputies and has one person to do all the clerical work. County B has two deputies, one clerk and one stenographer. County C has one deputy and one stenographer. The variation in percentage of the total expenditure devoted to administration is, however, small—County A spending 13 per cent and 14 per cent in 1913 and 1914 respectively. County B, 12 per cent, 12 per cent and 14 per cent in 1912, 1913 and 1914; and County C, 9 per cent, 13 per cent and 17 per cent in 1912, 1913 and 1914.

Inspection

Inspection includes all work done to find the breeding places of the mosquitoes, and means on the upland the complete examination of the entire territory approximately every two weeks throughout the four to five months of the breeding season. On the salt marsh it usually means the complete examination of the marsh following each flooding by extra high tide or heavy rainfall.

These examinations are made in different ways. County A has made a practice of assigning a district to one inspector and giving him some laborers. County B in 1912 and 1913 assigned a district to each

man and made him responsible for its condition. In 1914, however, a district was covered by a squad and the squads shifted from one district to another. County C has adhered to the plan of assigning a certain territory to one inspector and holding him responsible for its condition.

It should be said that the inspector is not a permanent employee and that his tenure begins and ends with the mosquito breeding season. Two to four inspectors are usually kept on throughout the year for the purpose of doing ditching and filling work and to serve as teachers for the inexperienced men of the larger force.

Of the total expenditures the percentage devoted to inspection shows considerable variation. In County A 18 per cent and 20 per cent were devoted to inspection in 1913 and 1914 respectively; in County B 45 per cent, 31 per cent, 24 per cent in 1912, 1913 and 1914; in County C 24 per cent, 28 per cent and 33 per cent in 1912, 1913 and 1914.

Elimination

Under the term elimination is included all those operations of draining, filling, oiling, cleaning and stocking with fish that are necessary to do away with mosquito breeding places. All the small jobs are attended to by the inspectors as they go about their duties, and a very considerable part of this work is thus cared for under the head of inspection. The treatment of the larger places is a matter for laborers employed by the commissions or for doing under contract.

A large share of the funds go to this work. In County A 63 per cent and 61 per cent were used in 1913 and 1914; in County B 33 per cent, 51 per cent and 54 per cent in 1912, 1913 and 1914; in County C 59 per cent, 46 per cent and 40 per cent in 1912, 1913 and 1914. Of the total expenditures for elimination only a part was used on the upland, the rest being expended on the salt marsh. Of the expenditure for all purposes, in County A 31 per cent and 32 per cent were used for elimination of upland breeding places in 1913 and 1914 respectively; in County B 19 per cent, 21 per cent and 23 per cent were used in 1912, 1913 and 1914; while in County C 32 per cent, 31 per cent and 21 per cent were employed in 1912, 1913 and 1914.

Thus it appears that about half of all expenditure is devoted to elimination of large breeding places, and that of this amount about one-half goes to the upland.

Equipment

Equipment covers spades, hooks, rubber boots, bicycles, motorcycles, automobiles, surveying instruments, tapes, chains, office furni-

ture, filing cases and typewriters. As might be expected, there is much variation in the amount and kind of equipment used by the different organizations.

The percentages of the total expenditures for equipment run as follows: County A, 5 per cent and 4 per cent in 1913 and 1914; County B, 9 per cent, 5 per cent and 7 per cent in 1912, 1913 and 1914; County C, 6 per cent, 6 per cent and 6 per cent in 1912, 1913 and 1914.

Education

Under the head of education is included the publication and distribution of educational pamphlets, the furnishing of newspaper and magazine articles, the giving of lectures, and the preparation and placing of exhibits.

With the exception of that used in publishing the annual reports, very little money has been expended on education. This is not due to little educational work having been done but to the fact that the administrative officers and commissioners have furnished much of the matter and the publishers have printed it without cost to the commission. In nearly all cases, however, it has been found advisable to prepare and distribute a simple statement of mosquito life history and control methods.

It should, also, be said that one of the most effective methods of education is found in the prompt and efficient prosecution of persons who insist on maintaining mosquito breeding nuisances.

Salt Marsh

From the time that Dr. John B. Smith completed his proof of salt marsh mosquito migration, it has been evident to all students of mosquito elimination that in every area within reach of a breeding salt marsh, mosquito control depends on the prevention of breeding on that marsh. This principle holds good for counties A, B and C now just as it did before drainage.

Drainage has not eliminated all the breeding but has cut it to a point where it can be controlled. In fact, there are certain parts of the salt marshes of Newark Bay and the Hackensack River where the ordinary ditching will not do the work of elimination even to this extent—where it is necessary to dike and tide-gate and in a few instances to pump.

That the commissions realize the importance of the salt marsh is indicated by the percentage of the total expenditures devoted to salt marsh work. In County A, 32 per cent and 29 per cent were used in 1913 and 1914; in County B, 14 per cent, 30 per cent and 31 per cent

in 1912, 1913 and 1914; in County C, 27 per cent, 15 per cent and 19 per cent in 1912, 1913 and 1914. As a matter of fact, the writer believes that the future will be likely to see a larger percentage go to the salt marsh instead of a smaller. The control of salt marsh breeding will continue to be a very important phase of mosquito work in counties A, B and C until the marshes are filled or brought under cultivation.

A Better Method of Determining the Efficiency of the Work

The writer believes that the greatest weakness of the mosquito control work, as he has seen it, lies in the fact that the mosquito fighting organizations are inclined to depend upon citizen complaints and a little scattering collection of mosquitoes on the wing to determine whether the work is efficient. The work of the past summer in collecting mosquitoes on the wing, in which Counties B and C coöperated so fully, clearly showed that between the absence of mosquitoes and citizen complaints there exists a considerable fauna of mosquitoes and that so long as this fauna does not increase beyond a certain point the householder does not recognize its presence. These collections further showed that regular, systematic, and frequent collections in all parts of the protected territory indicate the lack of local efficiency in time to prevent the mosquito fauna from reaching the danger point. It is the writer's belief that frequent, systematic, and regular night collections of mosquitoes on the wing should be made throughout the heavy breeding season, and that every mosquito fighting organization should make arrangements to have the specimens, which are collected, worked up and the results interpreted within 24 hours of the time the specimens have been taken.

Cost of Mosquito Control

Table Showing Distribution of Expenditures

	County A		County B			County C		
Year	1913	1914	1912 (5–6 mos.)	1913	1914	1912 (5–6 mos.)	1913	1914
Cost of Mos. Control								
Administration	13%	14%	12%	12%	14%	9%	13%	17%
Inspection	18%	20%	45%	31%	24%	24%	28%	33%
Elimination	31%	32%	19%	21%	23%	32%	31%	21%
Equipment	5%	4%	9%	5%	7%	6%	6%	6%
Education, Rept. & Miscellaneous	1%	1%	1%	1%	1%	2%	7%	4%
Salt Marsh	32%	29%	14%	30%	31%	27%	15%	19%
Per capita	5.07¢	5.42¢	6.37¢	11.9¢	11.37¢	10.57¢	28.22¢	15.89¢
Per sq. mile of habitable area	\$461	\$512	\$249	\$375	\$357	\$117	\$272	\$195

In reckoning the total cost of mosquito control, the lump sum expended should not be considered because the most tangible and immediate benefit derived does not admit of similar aggregation. Stating the matter in another way, it should be said that inasmuch as the most tangible and immediate benefit is personal, the cost should be reckoned on a per capita basis. From this standpoint mosquito control in County A cost 5.07 cents and 5.42 cents in 1913 and 1914; in County B, 6.37 cents, 11.9 cents and 11.37 cents in 1912, 1913 and 1914; while in County C it cost 10.57 cents, 28.22 cents, and 15.89 cents in 1912, 1913 and 1914.

For an explanation of these differences in per capita cost of the work, the conditions under which it was done must be examined. The work of 1912 began late and represents only 5–6 months. During the only years (1913 and 1914) when the three counties (A, B and C) were at work coincidently the percentage of the total expenditure, in Counties A and B, devoted to the salt marsh, was the same while County C spent about one-half as much as each of the others. The upland area of County A is only one-third that of County B and less than one-half that of County C. County A has a population of 13,275 to the square mile, County B, 4,515 and County C, 1,526.

On the basis of unit area (say per square mile) County A expended $461 in 1913 and $512 in 1914 as compared with $375 and $357 in County B, and $272 and $195 in County C. This higher unit-area cost is not due to poorer drainage conditions, for the upland in County A is better drained than that of either County B or County C. It seems rather to be chargeable to the larger number of breeding places which is incident to a denser population.

On the basis of per capita cost per unit of upland area the results are quite different. The per capita cost per square mile was 3.4 cents in 1913 and 3.8 cents in 1914 in County A, 8.3 cents and 7.8 cents in County B and 17.8 cents and 12.8 cents in County C.

It is distinctly indicated by these facts that other things being approximately equal, the cost of controlling mosquito breeding on the upland increases per unit of area as the population grows denser, but that the per capita cost decreases as the density of population increases.

Results of Mosquito Control

The results of mosquito control appear in increased comfort and health, and in increases in property values. No investigation of effect on property values has been made and there exist no reliable malarial records on which to base conclusions.

Evidences of results must therefore appear in what the people who are protected say and do about it. The first evidence is the attitude

of the newspapers which has become universally favorable. The second evidence appears in the attitude of the legal representatives of Counties A, B and C, who seem unwilling to tolerate any interference with the law under which the work is done. The third evidence is found in a post card census recently taken by the writer. A mailing list was made up from the telephone directory—so many A's so many B's, so many C's and so on through the alphabet, were taken from the lists of the various cities and towns within the limits of Counties A, B and C. To each member of this mailing list a letter was sent in which the expenditure that had been made during each year of the work in his county was set forth and he was asked to state on a stamped addressed card whether he had received an amount of protection equivalent to his share of the expenditure, and whether he approved the continuance of the work. One hundred and ninety-one cards have been received, 117 of which hold that they have had value received, 52 are doubtful, and 12 are sure they have not. Of the 191 cards received, 178 want the work continued and 13 desire it stopped.

President H. T. Fernald: The next paper on the program will be presented by R. A. Cooley.

THE SPOTTED FEVER TICK (DERMACENTOR VENUSTUS BANKS) AND ITS CONTROL IN THE BITTER ROOT VALLEY, MONTANA—A REVIEW

By R. A. Cooley, *Bozeman, Montana*

The purpose of this paper is to present in the briefest form, a summary of our knowledge of the Rocky Mountain spotted fever tick (*Dermacentor venustus* Banks) in Montana and to outline the control work now in progress.

This arachnid is the subject of much interest in the northwest for three reasons: (1) It is the carrier of Rocky Mountain spotted fever, (2) Recently it has been shown to be responsible for a new disease of man and certain domestic animals which has been given the name, "tick paralysis," and, (3) Finally, it is well recognized as a troublesome parasite of man and domestic animals.

Rocky Mountain Spotted Fever

By all odds the most important of the three is the relation to spotted fever. This disease has been scatteringly recorded over a wide ter-

ritory in the northwest, its distribution following, in a general way, that of the tick as given below. Spotted fever has not been well known among physicians in the wide range of territory indicated by the scattering cases reported and it is probable that many cases have passed unrecognized. It is best known in Montana and Idaho; and in Montana interest in the disease centers in the Bitter Root valley where most of the cases have occurred.

In Idaho the number of cases reported ranges around 375 to 400 per year with an average mortality of approximately 5 per cent;[1] while in the Bitter Root valley, Montana, the cases have ranged from 28 downward with an average of about 12 during recent years, but with a mortality of around 85 per cent. The fact that spotted fever is so fatal in Montana accounts for this state's being the center of interest in this disease.

Influence on Property Values and Business

There can be no doubt that the presence of spotted fever has influenced property values and the volume of business in the immediate region affected and also that exaggerated reports which have become current in the United States have injured the reputation of the state as a whole. Outside of the Bitter Root valley, and the region close around, spotted fever occurs in Montana, so far as is known, only in a restricted area in Carbon county, just north of Wyoming. In Idaho and Wyoming, and in Carbon county, Montana, spotted fever is not much feared on account of the low mortality and property values are not much affected.

Evidence Against the Tick

From the fact that ticks and tick bites were found on the bodies of fever patients, some residents in the Bitter Root valley had formed the opinion that ticks were the infective agents before scientists announced this fact.

The tick hypothesis first attracted general attention when Doctors Wilson and Chowning published the results of their study made in 1902 and 1903. The work of Doctor H. T. Ricketts, under the auspices of the Montana State Board of Health, established the fact of tick transmission, although somewhat earlier than his work, Doctors McCalla and Brereton in Boise, Idaho, had actually infected a man and a woman with the mild form of spotted fever by allowing a tick to attach to them which had been removed from a fever patient. Doctor Ricketts' work was experimental and methodically carried out. He repeatedly infected guinea pigs and other animals by means of ticks

[1] Maxey, *Medical Sentinel*, Portland, December, 1908.

under laboratory conditions and he collected ticks in nature and demonstrated their infectivity by allowing them to bite guinea pigs in which he had previously learned to diagnose the disease with certainty.

As bearing further evidence, it may be stated that the only precaution which the entomologists have taken in the work in the valley has been against being bitten by ticks and though living in even more apparent danger than the residents themselves, none has been infected.

Geographical Distribution of the Tick

The spotted fever tick occurs in the following states[1]; Washington, Oregon, Idaho, Montana, Wyoming, Nevada, Utah, Colorado, California and New Mexico. It also extends northward into British Columbia.

Only a small proportion of the ticks in the Bitter Root valley are infective and throughout the geographical range of the species, only here and there a locality occurs which contains any infective individuals.

Life-History

An intimate understanding of the life-history of this tick comes only through a knowledge of the host relationships in the various stages, the habits and abundance of the host animals, and the relation of the development of the tick to the succession of seasons.

These subjects will be briefly reviewed.

Host Relationships.—The larvæ and nymphs use very much the same list of mammals as hosts, and availability is apparently a greater factor than choice in determining what species of mammals shall be used. Practically all the species of small mammals occurring in the valley have been found to serve as hosts, but the ground squirrel (*Citellus columbianus*), the pine-squirrel (*Sciurus hudsonicus richardsoni*) and the chipmunk (*Eutamias luteiventris*), because of their numbers and activity, undoubtedly feed the great bulk of all the larvæ and nymphs that secure food. The adults feed only, or with few exceptions, on large animals. Under the conditions that prevail in the Bitter Root valley, as distinguished from the contiguous mountains, practically all of the adults that are fed use domestic animals, horses and cows principally, as hosts. Back into the mountains, ticks become less abundant, disappearing almost entirely when the limit of the range of domestic animals is reached.

Still further back, beyond this limit, in the "goat country," as it is called, or the natural habitat of the Rocky Mountain Goat (*Oream-*

[1] Bishopp. Distribution of the Rocky Mountain spotted fever tick. Circular 136, Bureau of Entomology, 1911.

nus mountanus) a region which is very wild and very inaccessible, this tick is exceedingly abundant. There appears to be an exception to the limitation of ticks to the range of domestic animals, in the mountains near Victor, where, as Doctor L. D. Fricks has pointed out, ticks continue to be abundant beyond these limits. Outside of this exception, the number of adult ticks that engorge on wild animals either in the valley floor, the first reaches in the mountains, or deeper into the mountains below the goat ranges, is so small as to be of no particular significance from a control standpoint. Or, in other words, if those which develop on domestic animals were entirely eliminated, ticks would scarcely ever be seen by those who reside in the valley and infections would cease.

The ticks are more abundant than elsewhere along the border country, between the valley and the mountains. The presence of a known danger there makes this border country less desirable for tillage purposes and it is naturally given over to pasturage, and, as ground squirrels are abundant there, the conditions are made perfect for a continuation of the difficulty.

The host relationships may be summarized then by saying that the mature stages are fed on small mammals only and the adults, practically speaking, are confined to domestic animals, so far as the habitable valley is concerned, with the exception of a certain mountainous district back of Victor.

These facts have an important bearing on eradication. Domestic animals can be controlled. By dipping and by other means they may be kept free of ticks and if the species is prevented from engorging and laying eggs, it must die out, and with the disappearance of the tick, the disease must go.

However, certain facts connected with the seasonal history also have an important bearing on control and these are now discussed.

Seasonal History

Previous workers had believed that the tick completes the life cycle in one year. When in 1911 detailed records were secured this was found to be quite impossible. It was found that the winter is passed both as adults and as nymphs, but that the hibernating individuals of these two stages belong to different generations. On these grounds, therefore, it was necessary to conclude that the life-cycle is at least two years long.

In connection with longevity studies, it has been shown that adults which fail to secure a host during the first season following nymphal feeding, do not die but go down to the ground during July and come up again the next year, in the spring, and continue to wait for a

host. Thus, it is apparent that a part of each brood may prolong life in this manner, thus making the cycle three years instead of two.

Studies now under way indicate the possibility of a still further lengthening of the life-cycle.

With these facts in view it is apparent that with very thorough work done in a given district, resulting in preventing any females from engorging and laying eggs for two consecutive years, there still may be adults present in the third season, or if only incomplete work has been done for three or four years even, there still will be adults present in later years.

Control

The foregoing facts regarding the host relationships have indicated a practical plan of controlling the tick in the valley. It is evident since engorgement is necessary before egg-laying, that if no adults are allowed to engorge the species cannot continue. This point is believed to be of much importance and has led to the adoption of dipping of domestic animals as a main dependence in the program. There are two limitations to this method which we recognize, but these we think are not serious. One is the fact that some adults may engorge on wild animals, such as the coyote, bear and deer. These animals are not abundant in the valley and we believe that the small number of engorged adults which they drop may be neglected. The practicability of getting all owners of stock to dip under the conditions found in the valley is more serious. If spotted fever affected the animals instead of man, it would apparently be less difficult to secure the owners' coöperation. A slight danger of injury to the animals is greatly magnified and the residents wish to see some other method of tick destruction developed. The arsenical dip in use has been found to be effective and we believe that as the farmers gain confidence dipping will be more generally adopted. However, notwithstanding this limitation many animals are already being dipped and thereby freed of ticks.

Rodent destruction naturally suggests itself as a method of control. Ground squirrels are very abundant and the property owners are quite willing that they should be killed off. Some work in this direction has been done and there can be no doubt that it is of value in the destruction of ticks as we have found that this rodent, far more than any other, is responsible for the feeding of larvæ and nymph ticks. The cost of this work under the conditions that prevail in the region affected is such as to raise a serious obstacle. This might, however, be overcome if the killing of this squirrel alone would be a sufficient means of getting rid of the tick. It is apparent that since the early stages of the tick feed also on other rodents, other means of tick killing will eventually be needed. It is not yet clear that with ground squirrels eliminated there

may not yet be enough young fed on other rodents to keep up a serious infestation if domestic animals are allowed in the same territory and left undipped.

It seems probable that squirrel destruction is desirable only in combination with dipping and that in this combination it will be useful and lead to an earlier solution of the difficulty.

Recently Doctor L. D. Fricks of the United States Public Health Service has advanced the idea that the grazing of sheep over tick country may be useful as a supplementary method in the destruction of ticks. He has found that many adults are killed in the wool of the sheep. Experimental work and practical tests are being conducted. The Bureau of Entomology has also made some studies on sheep as automatic destroyers and has found that some females engorge on the sheep and produce eggs which hatch.

The work on sheep as tick destroyers is in an experimental stage. It is not yet clear whether the number that will succeed in feeding to maturity on sheep will be a serious drawback to this method.

Organization

The work on tick control in Montana is being conducted under a plan of coöperation embracing the Montana State Board of Entomology, the United States Bureau of Entomology and the United States Public Health Service. The State Board of Entomology was created by the Montana Legislature in February 1913. The membership of this Board is *ex officio* and made up of the secretary of the State Board of Health, the State Veterinary Surgeon and the State Entomologist. The secretary of the Board of Health is chairman and the Entomologist, secretary. This Board is given authority among other things, to prescribe and enforce rules and regulations for the eradication of the spotted fever tick. The two federal services named are engaged in the work in different portions of the Bitter Root valley, under such legal machinery from the State Board of Entomology as has been found necessary from time to time.

The technical information concerning the tick on which the control work is mainly based, has been secured through the joint efforts of the Montana Experiment Station and the Bureau of Entomology. The work has been planned and directed by Mr. W. D. Hunter and the writer, while various men in the Bureau have contributed valuable assistance. The field work in the Bitter Root valley was done mainly by Mr. W. V. King, and the breeding and other laboratory work was done in the Bureau's laboratory in Dallas by Messrs. C. F. Bishopp and H. P. Wood.

The Bureau of Biological Survey, through Dr. A. K. Fisher, gave

us invaluable assistance by securing needed information concerning the mammalian fauna of the valley and nearby mountains and especially by certain experimental work on the destruction of squirrels. The field work for this Bureau was done by Mr. A. H. Howell and Mr. C. Birdseye.

An unusual character of personal service has been willingly given by those who have been engaged on this problem in the field work. This applies alike to the pathologists, the entomologists and mammalogists who have not hesitated to go into the presence of known danger. Especial mention should be made of Messrs. King, Fricks, Birdseye and Wood who have made prolonged stays in the field and finally of Dr. H. T. Ricketts who through several years was almost constantly exposed to dangers known and unknown and finally lost his life by typhus fever while engaged in what was really a part of the spotted fever investigation and of Dr. T. B. McClintock who contracted spotted fever and gave his life, while engaged in the field, a sacrifice to his devotion to this cause.

This devotion has not been in vain. There can be no doubt that a considerable number of lives have already been saved. In spite of the fact that the population of the Bitter Root valley is increasing and of the further fact that the disease is slowly spreading, fewer cases have occurred in recent years since the work was begun than before. During the season just closed only one case occurred in the heart of the district where in former years a high proportion of all the cases have been contracted. The cases recorded this year were with the exception of this one, from territory where the work was not begun. This is due not to any material reduction of ticks as yet, but to the adoption by many of the residents of the valley of the means of self defense employed by the scientists who are in the work.

Bringing the spotted fever tick under complete control will require some years. The territory involved is extensive and the methods which will be effective in one district will not be as effective in another. Educational work among the people must be pushed in advance of actual control and the life history of the tick is such that thoroughly effective measures must be pursued through a term of years in order to secure the desired end.

President H. T. Fernald: Is there any discussion on this paper?

Vice-President Herrick: I would like to ask Professor Cooley if the tick was responsible for the paralysis in those sheep shown on the screen?

Mr. R. A. Cooley: Yes. I would call attention to a recent work

by Doctor Seymour Hadwin, published in the *Journal of Parasitology*, and also to the expression of a definite opinion by Doctor George H. F. Nuttall of England to the effect that we should no longer hesitate to say that this is a definite disease. The ticks attached and induced the paralysis. They often attach on the base of the skull or along the spine. The paralysis progresses from the lower part upward and the removal of the tick results in a sudden recovery of the child.

President H. T. Fernald: Mr. F. C. Bishopp has submitted a title and asked for fifteen minutes. He desires to present two short papers in this time. If there is no objection, both will be presented within the fifteen minute time limit.

[The speaker summarized two papers. One is given below. The other will appear with papers read by title. Ed.]

NOTES ON CERTAIN POINTS OF ECONOMIC IMPORTANCE IN THE BIOLOGY OF THE HOUSE FLY[1]

By F. C. Bishopp, W. E. Dove, and D. C. Parman, *Bureau of Entomology*

The first impression one gains by running over the voluminous literature relating to the house fly or typhoid fly (*Musca domestica* Linn.) is that our knowledge of that insect and its control leaves little to be desired. To be sure, the admirable investigations of Doctor Howard, Doctor Hewitt, and many other entomologists here and abroad have given us complete and reliable information on the vast majority of points in the life history and habits of this pest and have pointed out means of their practical application. However some points have not been determined while others which have been investigated should receive further attention. The importance of accumulating information regarding the biologies and habits of insects of wide distribution in a number of regions representing different climatological or economic conditions, is coming more to be recognized.

At the suggestion of Dr. L. O. Howard and Mr. W. D. Hunter experiments were undertaken to determine, under Texas conditions, two of the more important biological questions requiring further study. These were the duration of the period from emergence of the adult fly to the deposition of the first eggs (spoken of herein as the preoviposition period) and how the insect passes the winter. It was thought best in carrying out these experiments to broaden the inquiry so as to obtain accurate information on other important points. These included: The determination of the duration of the different developmental stages of the insect, the longevity of adults, the number of

[1] Published by permission of the Chief of the Bureau of Entomology.

depositions and interval between each, and notes on the effect of temperature and humidity on the several stages. Some part of these are discussed herein. The character of most of the biological points to be determined necessitated the use of cages. It is well known that conditions in cages are always more or less abnormal. This is true in the tests herein reported, but we feel that by the methods employed natural conditions were closely simulated in most cases, thus reducing this source of error to a minimum. The tables given herein include representatives chosen from numerous experiments carried out.

The experimental work was carried out at Dallas and Uvalde, Texas, with supplementary field observations at Victoria, Texas, by Mr. J. D. Mitchell. The detailed work at Dallas was carried out by W. E. Dove, assisted by F. C. Bishopp, who planned and supervised all of the work, and the experiments at Uvalde were carried out by D. C. Parman.

Further experiments bearing on hibernation and certain other points are now under way at Dallas and Uvalde.

Copulation

In a number of our preoviposition tests frequent observations were made for copulation. Although continuous watch was not kept on the flies it is thought that in some cases at least the first copulation which took place was observed. The date when copulation was observed in a number of experiments is given under "Remarks" in Table No. 1. The shortest period from emergence to copulation observed was one day. In a number of instances two full days elapsed, and in other cases copulation was first observed as late as the sixteenth day after emergence. Of course mating may have taken place unobserved before this. The time from the first observance of copulation to the first deposition varies greatly. Frequently there appears to be no direct relationship between the date of copulation and beginning of deposition. We have observed a range of two to thirteen days between the first copulation observed and deposition.

It appears from our experiments that the time of development or manifestation of the desire to mate is influenced to some extent at least by the food of the adults. Thus in a test with two lots of flies, one supplied with milk and horse manure and the other with partially ripened peaches and horse manure, the former were first observed to copulate four days after emergence and the latter sixteen days. In no case was copulation observed among unfed adults.

The process of copulation is always of considerable duration—lasting from two or three to as long as fifteen minutes. During the act the flies usually remain quiet, but if disturbed may fly about considerably without becoming separated. Often prior to copulation and

TABLE 1. PREOVIPOSITION PERIOD OF THE HOUSE FLY AT DALLAS, TEXAS

Adults Emerged	Number Adults			Food Supplied	Breeding Media Supplied	First Eggs Deposited	Preoviposition Period (shortest)	Temp. During Preoviposition Period			Remarks
	♂	♀	Total					Highest	Lowest	Average Daily Mean	
1913 July 28, 5 p.m.–July 29, 12 m.	11	7	18	Peaches and horse manure	Horse manure (not fresh)	Aug. 6*	Days 8 (about)	°F. 104.0	°F. 69.9	86.0	*One day old larvæ found Aug. 7, p.m.
Aug. 6, 3.30 p.m.–Aug. 7, 10 a.m.	....	....	225	Peaches and horse manure	Horse manure	Aug. 14*	8 (about)	105.0	71.5	88.3	*One day old larvæ found Aug. 15.
Aug. 14, 6 p.m.–Aug. 15, 10 a.m.	....	....	9	Peaches, water, horse manure	Horse manure (fresh)	Aug. 18, 4 p.m.	4	102.4	72.5	87.5	Copulation Aug. 16, 3 p.m.
Aug. 19, 5.30 p.m.–Aug. 20, 9.30 a.m	4	8	12	Peaches	Peaches	Sept. 5, 9 a.m	16	104.4	65.5	85.2	Copulation Aug. 22, a.m.
Aug. 20, 5.30 p.m.–Aug. 21, 10.30 a.m.	11	11	22	Milk, peaches, horse manure	Horse manure	Aug. 26, 9 a.m.	5	101.8	65.5	83.9	
Aug. 24, 5.30 p.m.–Aug. 25, 10 a.m.	1	1	2	Milk, peaches, horse manure	Horse manure	Sept. 6, a.m.	12	106.0	69.0	85.9	Copulation Aug. 27, a.m.
Aug. 27, 5.30 p.m.–Aug. 28, 9 a.m.	1	1	2	Milk, peaches, horse manure	Horse manure	Sept. 5, 4 to 5 p.m.	9	106.0	69.5	86.0	Copulation Aug. 29, a.m.
Sept. 8, a.m.	7	2	9	Milk, peaches, horse manure	Horse manure	Sept. 15, p.m.	8	92.0	56.6	72.0	

Sept. 11, a.m.	....	....	A No.	Milk, horse manure	Horse manure	Sept. 16, p.m.	6	83.0	56.6	67.6	Copulation Sept. 15, a.m.
Sept. 11, a.m.	....	....	7	Peaches, horse manure	Horse manure	Oct. 1, a.m.	20	92.7	47.1	68.1	Copulation Sept. 27, a.m.
Nov. 7, 10.30 a.m.-2.30 p.m.	5	5	10	Horse manure, milk and bananas	Horse manure	Nov. 20, a.m.	13	80.0	33.7	64.0	Copulation Nov. 15, p.m.
1914 May 16, 10.30 a.m.-2.30 p.m.	....	....	Many	Bananas, horse manure	Horse manure	May 20, 4 p.m.	4½	81.3	51.9	68.8	Copulation May 18, p.m. medium cage.
June 23, 3 p.m.-June 24, 3 p.m.	....	....	100	Milk, plums, horse manure	Horse manure	June 29, p.m.	6	101.5	73.1	86.9	
July 3, 9.30 a.m.-2.30 p.m.	....	....	18	Milk, plums, horse manure	Horse manure	July 9, p.m.	7	94.1	70.7	87.8	
July 8, 5 p.m.-July 9, 5 p.m.	....	....	350	Milk, peaches, *cow manure, horse manure	Cow and horse manure	July 14, m.	5¾	104.0	73.9	87.7	*Cow manure supplied till July 16. Many females deposited.
July 9, 9 a.m.-July 10, 9 a.m.	....	1	1	Milk, bananas, peaches, *horse manure	Horse manure	July 17, by 10 a.m.	7	104.0	73.9	88.1	*Horse manure supplied July 16, 4.30 p.m.
July 27, 10 a.m.-July 28, 10 a.m.	....	....	200	Cantaloupe, horse manure	Horse manure	Aug. 2, p.m.	7	104.3	70.0	87.3	Copulation Aug. 1, p.m. Large cage.
Oct. 22, 10 a.m.-5 p.m.	....	....	700	Milk, bananas, cow manure, horse manure	Cow manure, horse manure	Nov. 1, between 9 a. m. and 4 p. m.	10	84.9	32.1	61.9	Oct. 27, a.m. 1st copulation observed. Large cage.

after copulation has taken place the sexes fly together or the males temporarily alight on the females. This appears to be in the nature of courting. When not ready to accept the attentions of the male the female protects herself largely with her posterior legs which are kept near the tip of her abdomen.

The Preoviposition Period

In 1907, Dr. C. Gordon Hewitt, working in England, found that a period of fourteen days elapsed between the emergence of adults from puparia and the first egg deposition by them.[1] In experiments at Hove, England, Dr. A. Griffith determined the preoviposition period to be ten days.[2] Professor A. Berlese has also published results of observations made by him on the reduction of numbers of the house fly in S. Vincenzo, Italy, due to the poisoning of adult flies incidental to the spraying of olive trees for the control of the olive fly.[3] Professor Berlese also secured satisfactory results in controlling the insect by spraying vegetation, manure and garbage with poisoned sweets.

In order to determine the preoviposition period a series of experiments were conducted at Dallas and Uvalde. In these tests cages of various sizes from one foot cubes to cages ten feet square by six feet high, were utilized; the latter appeared to furnish almost ideal conditions. These were placed in partial or complete shade or in open sunshine. Freshly emerged flies were used in numbers varying from a pair to several hundred. Different kinds of food were supplied and the breeding media were also varied. A few of the experiments are summarized in table 1.

It will be seen in Table No. 1 that the shortest preoviposition period observed at Dallas was four days and the longest twenty days. The mean temperatures during these periods were 87.5° F. and 68.1° F., respectively. The usual preoviposition period during the summer at Dallas appears to range from four to about nine days. While in autumn it is probably never shorter than ten days. Although it is certain that temperature has much to do with the development of the ova in flies, it is also evident that the food supply, both abundance and quality, is an important factor. This is well illustrated in the lot of flies which emerge between August 19, 5.30 p. m. and August 20, 9.30 a. m. and were given nothing but cut peaches for food and breeding medium as compared with flies which emerged between August 20,

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[1] 1910. Hewitt, C. Gordon. The house fly; a study of its structure, development, bionomics, and economy, p. 64.

[2] 1908. Griffith, A. The life history of house flies. *Public Health*, Vol. XXI, pp. 122–127.

[3] 1913. Berlese, A. La distruzione della Mosca domestica. *Redia*, Vol. VIII, Pt. 2, pp. 462–472, 4 figs.

5.30 p. m. and August 21, 10.30 a. m. and were supplied with milk, peaches, and horse manure. The temperature and humidity in these two cases were practically identical, yet the flies on peaches required sixteen days for egg production while those given the variety of foods deposited in five days.

The humidity also appears to have a bearing on the duration of this period. In general when the temperatures are high or moderately high, increased humidity seems to hasten egg laying. This is probably partially due to the effect of humidity on the food and breeding substances—keeping them moist and thus attractive. Our observations lead us to think that sunshine, aside from higher temperature, has a stimulating effect on reproduction and other activities in flies.

The preoviposition periods recorded in the table are the shortest observed in each lot of flies; in many cases only a few masses of eggs were deposited in a test. In several tests, with large numbers of flies under favorable conditions, a number of females began depositing about the same time, or not more than twenty-four hours later than the first.

In most of our tests with single pairs the preoviposition periods were longer than when a number of flies were kept together.

At Uvalde several preoviposition experiments were conducted but in nearly all the flies failed to deposit. In one test made in June the period was about six days.

Milk appears to be a good food for ova development. This substance with manure was found to be adequate for producing oviposition. Over-ripe fruit with manure was also found to be satisfactory. The effect of the condition of food on egg production may be illustrated by referring to Table No. 1. In one instance where milk and horse manure were supplied deposition took place in six days. In a parallel test where partially ripened peaches were substituted for the milk, the first deposition occurred on the twentieth day after emergence. Manure either of horses or cattle, appears to be inadequate as a food for egg production in the house fly.

Based upon our experiments it appears that, in Texas, it is necessary to capture or destroy the female flies within four days after emergence in summer and within ten days in fall and early spring in order to prevent reproduction. The shortness of the preoviposition period as determined by us emphasizes the importance of laying special stress on the prevention of breeding by caring for breeding media, as urged by Doctor Howard, rather than the destruction of adults, as the more important control measure. This seems especially true in the tropics and subtropics where the preoviposition period is short, successive depositions frequent and longevity of the adult reduced.

Deposition

The determination of the egg-laying period of a fly or group of flies is important in that it shows the value of destroying the adult at different times in its career as relates to reproduction. In most of our tests the total time from the beginning of laying to the deposition of the last eggs was comparatively short, the adults often living several days after the last eggs were deposited.

Dr. A. Griffith, reporting on experiments conducted by him in England, says: "After ten days the mother-fly can lay a new batch of eggs, which process it repeats at intervals of ten to fourteen days, till four batches have been layed, when it dies."[1] Our observations indicate that in Texas fewer batches of eggs, the usual number being two, are deposited and that depositions take place at shorter intervals—about eight days.

Oviposition was observed to occur on warm days in mid-winter at Dallas (January 14) and Uvalde (February 5). Depositions may be expected at these latitudes on mild bright days in winter, especially if these are preceded by a few days of mild weather.

During cool weather adults seem to choose places for deposition where the sun is bright and the wind is cut off. They also prefer portions of the pile where heat is emanating from beneath, provided the media is suitable. In summer this is less noticeable though in mornings and evenings sunny places seem preferred.

We have observed a marked tendency to clustering of eggs in one place on manure piles. In many instances from three to over a dozen flies have been observed depositing in one spot in a manure pile and scarcely a depositing fly or an egg could be found elsewhere, although equally favorable places seemed to exist. This habit of association of individuals seems to continue to some extent in the larval stage, although this is probably more dependent on suitable feeding places, and the fact that the larvæ hatch largely in one mass. Great masses of larvæ have also been observed to pupate in one place. This is probably due, in part at least, to many of the larvæ following the line of least resistance in migrating and the finding of a place which furnishes proper protection and moisture and is not too compact.

Developmental Periods

Incidental to other observations the developmental periods were determined in a large series of tests at different times of year. The total period from the deposition of the eggs to the emergence of adults

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[1] 1908. Griffith, A. The life history of house flies. *Public Health*, Vol. XXI, p. 123.

in our breeding experiments ranged from eight days to fifty-one days. A much longer period was observed in hibernation experiments at Dallas and Uvalde, Texas. In one of these tests at Dallas a combined larval and pupal period of six months was observed and in the instance at Uvalde larvæ and pupæ put in a box with the manure in which they were breeding on December 13, 1913, produced some adult flies as late as April 4, 1914, a period of one hundred and twelve days. The amount of manure was not sufficiently large to generate heat, but protected the stages from extreme cold. No doubt during the coldest weather development was completely arrested.

The data appertaining to a number of the tests to determine the developmental periods are given in Table No. 2. In most of these tests a comparatively small amount of breeding material was used in order to observe the stages more closely. Hence these periods, especially the larval, are in general rather longer than would occur under favorable natural conditions.

Egg Stage.—The exact incubation period was determined in only a few instances. In practically all cases it was found to be less than twenty-four hours even in winter. When eggs are deposited on manure piles of considerable size the temperature experienced by them is much above the air temperature during cool weather, and this accounts for the short periods observed in winter. When eggs are separated from the mass of manure the period is greatly lengthened during cool weather. This is well illustrated in two of the lots upon which data are given in Table No. 2. In one case, eggs deposited on January 14, 1914, hatching of those left on a manure heap took place in less than seventeen hours, while part of the same lot kept in the laboratory on a small lot of manure did not begin hatching until forty-one hours after deposition, and was not complete till eight hours later.

Larval Stage.—The larval stage was found to vary in length from three and one-half days to about three weeks. In a hibernation test where the manure was not in a fermenting condition the larval stage was observed to persist for nearly four months. In one case a period of a little less than three days was observed. The usual time required from hatching to the formation of the first pupæ during warm weather was from four to seven days. The temperature materially affects the larval period but the character and particularly the amount of the breeding medium was found to be of still greater importance as factors, under natural conditions. By character we refer to the kind of material, the amount of moisture it contains, and the degree of fermentation. In large piles of manure it was observed that to a marked extent the larvæ govern their temperature conditions by penetrating farther into the manure during cold weather and remaining nearer the surface when the weather was warm.

TABLE 2. DEVELOPMENTAL PERIODS OF THE HOUSE FLY AT DALLAS, TEXAS

Date First Eggs Deposited	Date Hatching Began	Incubation Period	Date of Pupation		Length Larval Stage	Date Adults Emerged		Range in Pupal Period	Total Developmental Period		Breeding Media	Remarks
			First	Last		First	Last		Min.	Max.		
1913	1913	Hours	1913	1913	Days	1913	1913	Days	Days	Days		
July 29, 11.30 a.m.–12.30 p.m.	July 30 before 10 a.m.	22½–	Aug. 3 before 9 a.m.	....	4	Aug. 6, 10 a.m.–3.30 p.m.	Aug. 9, a.m.	3 to 6	8	11	Horse manure	Small cage in laboratory.
Aug. 18, 3.45 p.m. or before.	Aug. 19, 2.30 p.m. or before	23±	Aug. 23 before 10.30 a.m.	Aug. 25,	4–	Aug. 27, 10 a.m.–5.30 p.m.	Aug. 30, 11.30 a m.	4 to 7	9	12	Horse manure	Small cage.
Aug. 26, 9 a.m.	Aug. 27, before 9.30 a.m.	24½±	Aug. 31, 12 m.	Sept. 6, 9 a.m.	4	Sept. 7, 5 p.m.	Sept. 11, a.m.	7+ to 10	13	16	Horse manure	Small cage.
Aug. 28	....	....	Sept. 5	....	7–	Sept 8, a.m.	Sept. 16+	3 to 11	11	19+	Horse manure	Large mass of manure. Adult emergence not observed after Sept. 16.
Sept. 4, 3 p.m.–5 p.m.	Sept. 5 before 9 a.m.	18–	Sept. 10, a.m.	....	5	Sept. 18, a.m.	Sept. 25, a.m.	8 to 15	14	21	Horse manure	
Sept. 11, p.m. (?)	Sept. 12, a.m.	24–	Sept. 23, a.m.	Sept. 26, a.m.	11 to 14	Sept. 30, a.m.	Oct. 1, a.m.	5 to 8	19	20	Horse manure	Small cage.
Sept. 15, p.m.	Sept. 16, a.m.	24–	Sept. 29, a.m.	....	13	Oct. 5, a.m.	Oct. 5, a.m.	6	20	....	Horse manure	Medium cage.

1914 Jan. 14, 4 p.m.	1914 Jan. 15 before 9 a.m.	Hours 17½—	1914 Feb. 5 or before.	1914	Days 21—	1914 Feb. 8 or before	1914	Days	Days 25	Days	Horse and cow manure and straw	In large manure pile, Feb. 5 many larvæ present also.
Jan. 14, 4 p.m.	Jan. 16, 9 a.m.	41	Feb. 3 or before	....	23 or less	Mar. 6, a.m.	....	26 or more	51	....	Horse manure	Small cage in laboratory.
Apr. 1, 2 p.m.	Apr. 2, 10 a.m. Apr. 3, 9 a.m.	24 to 48	Apr. 11 (?)	....	8±	Apr. 16, a.m.	Apr. 19, a.m.	5? to 8?	15	18	Cow manure	Small cage in manure pile.
May 20, 4 p.m.	May 21 before 10 a.m.	18—	May 24, p.m.	....	3½	May 29, a.m.	June 1	5 to 8	9	12	Horse manure	Small cage.
May 27	May 28	24±	June 14	....	17	June 20	....	6	24	....	Bananas	Small cage.
July 9 before 5 p.m.	July 10 before 9 a.m.	....	July 18, probably before	....	8	July 20	July 23	....	11	14	Horse manure	Small cage.
July 14, 10 a.m.–12 m.	July 15 before 9 a.m.	23—	July 19, 9 a.m.	After July 23	4 to 8+	July 24, 10 a.m.	July 26	5	10	12	Cow manure	A few larvæ not pupated July 23.
Aug. 4 after 3 p.m.	Aug. 5, 9 a.m. or before	18—	Aug. 11, 8 p.m.	Aug. 20	6	Aug. 14, p.m.	Aug. 17, a.m.	3 to 6	10	13	Dead flies	Last pupæ died.
Aug. 5, 9.30 a.m. –5.30 p.m.	Aug. 6 before 9 a.m.	23½±	Aug. 8, p.m.	After Aug. 17	3—	Aug. 13, a.m.	Aug. 19	5	8	14	Horse manure	
Oct. 3, 1.30-2.30, p.m.	Oct. 4, 1.30 p.m.	23 to 24	Before Oct. 18	Nov. 4	14 —to 31	Oct. 19	Nov. 7	1+ to 20	16	35	Cow manure	Small cage in laboratory.

Pupal Stage.—The pupal stage was found to range from three to at least twenty-six days in our experiments to determine this point with exactness. The temperature is an important governing factor. It is probable that its influence on the length of the pupal period is even more marked than on the length of the larval stage as the pupæ are usually more removed from the heat of the manure and they have no way of accommodating themselves to changes in temperature, as do the larvæ. In one of our hibernation experiments at Uvalde, Texas, in 1914, it appeared that a good many individuals remained in the pupal stage from January 27 to April 4, or over two months.

Breeding Material

As has been observed by many entomologists, horse manure is a very favorable breeding medium for the house fly. In Texas we have found them to breed freely in the manure of the chicken, hog, goat, and to a large extent in pure cow manure, provided other more attractive media are not present. The latter substance is not as attractive as some other materials. Decaying vegetable matter and kitchen refuse also form important sources for fly breeding; this is especially true around cities where rather large accumulations of each substance are found. At the dumping grounds around Dallas large quantities of decaying potatoes were found which seemed to be ideal for house fly breeding, producing countless numbers of them. Decaying melons and mixtures of kitchen refuse were also found to breed considerable numbers. The paunch contents of animals were found to furnish favorable breeding places for house flies after the bodies of the animals had been consumed by scavengers. In the grain belt of Texas, Oklahoma, and the states to the north, the bases of stacks of oat or wheat straw which had become well rotted were found in some instances to breed many house flies. The straw during the first year after thrashing, although in a high state of fermentation, is not favorable for house fly breeding although myriads of stable flies may breed in it. Well-decayed straw stacks or the remains of stacks after being burned should be considered in fighting the house fly in rural communities. Ensilage scattered about silos or in troughs has been found very favorable for house fly breeding, and fermenting cottonseed hulls mixed with bran, etc., in the bottom of feed boxes or troughs have been found to produce flies beyond all expectations.

Longevity

When considering the destruction of house flies in the adult stage the question of their longevity is one of importance. A number of experiments upon this point have been conducted in Europe, but little

is known regarding longevity in the United States, particularly in the Southern States. In England, Doctor Hewitt found it possible to keep house flies alive for seven weeks in the summer time. Doctor Griffith, in his experiments, also in England, had a fly live for sixteen weeks.

We have conducted a large number of experiments in Dallas under varying conditions of climate, food, and cages. Representative experiments are cited in Table No. 3. It will be observed that the longevity is greatly reduced where food is not given; the usual longevity being from two to three days when no food or water was supplied, while with food supplied it ranged from a very few days up to fifty-three days. This maximum record was made during late fall and early winter. Food and breeding material were supplied and eggs were deposited by flies in this test. In a few tests horse manure alone was supplied. This prolonged life slightly but did not seem to form a maintenance ration, and no eggs were deposited by flies under such conditions. During summer the usual longevity of flies, in cages at Dallas, supplied with an abundance of food and breeding material, was from two to four weeks. Cool weather invariably prolongs the life of the adults, correspondingly delaying reproduction, as has been stated.

Hibernation

It has been assumed generally until recently that the house fly passes the winter in the adult stage only. No definite experiments have been reported to substantiate this belief, although a considerable amount of circumstantial evidence has been presented by various authors; such as the observations by Doctor Hewitt, that flies dissected in fall had much fat stored up in their bodies and in spring this fat was not in evidence.[1] The finding of adults in dormant, semi-dormant and active states in various situations in mid-winter, and the greater longevity exhibited by adults emerging late in fall, has also lent weight to this conclusion. It is our opinion that these conditions do not necessarily indicate that this species passes the winter in the adult stage.

Our experiments, as will be shown later, prove that the house fly can pass the winter in the immature stages in the vicinity of Dallas and Uvalde. Moreover, in our tests we failed to get adults to live through the winter. All our observations indicate that flies which are not kept cold enough to become inactive will either deposit, if the temperature is sufficiently high, or die comparatively soon. It is conceivable that some adult flies may happen to find shelter, which

[1] 1910. Hewitt, C. G. The house fly; a study of its structure, development, bionomics and economy, p. 364.

Table 3. Longevity of the Adult House Fly at Dallas, Texas

Date Adults Emerged	Number Flies			Food Supplied	Date Last Fly Died	Greatest Longevity	Remarks
	♂	♀	Total				
1913 July 29	11	7	18	Peaches, horse manure	Aug. 16 (♂)	Days 18	Last flies drowned, small cage, eggs deposited.
Aug. 7	....	....	225	Peaches, horse manure	Aug. 20	13	Small cage, eggs deposited
Aug. 15	....	....	9	Peaches, water, horse manure	Aug. 31	16	Small cage, eggs deposited.
Aug. 16	7	7	14	Peaches, water, horse manure	Aug. 30	14	Small cage, no eggs deposited.
Aug. 21	10	10	20	Horse manure	Aug. 25	4	Small cage, no eggs deposited.
Aug. 21	9	11	20	Milk, horse manure	Sept. 10	20	Small cage, eggs deposited.
Aug. 25	1	1	2	Peaches, milk, horse manure	Sept. 23	29	Small cage, eggs deposited.
Aug. 28	1	1	2	Peaches, milk, horse manure	Sept. 17 (♀)	20	Small cage, eggs deposited.
Aug. 28	....	....	16	Water	Aug. 31 (♀)	3	Small cage, no eggs deposited.
Aug. 30	....	....	Many	Horse manure	Sept. 4	5	Small cage, no eggs deposited.
Sept. 11	....	....	25	No food	Sept. 17	6	Small cage, no eggs deposited.
Sept. 11	....	....	48	Water, horse manure	Sept. 18	7	Small cage, no eggs deposited.
Nov. 7	1	1	2	Bananas, milk, horse manure	Dec. 21	44	Small cage, eggs deposited.
Nov. 7	1	1	2	Bananas, milk, horse manure	Dec. 9	32	Small cage, eggs deposited.

1914 Before Apr. 17	1	1	2	Bananas, horse manure	May 14 (♀)	27+	Small cage, ♂ escaped, no eggs deposited.
May 16	....	....	250	Bananas, horse manure	June 8	23	Medium cage, eggs deposited.
June 23	....	....	100	Plums, milk, horse manure	July 18	25	Medium cage, eggs deposited.
July 3	....	....	60	No food or water	July 5, p.m.	3	Medium cage.
July 3	....	....	18	Plums, milk, horse manure	July 30	27	Small cage, eggs deposited.
July 9	....	....	350	Banana, milk, horse manure	July 28	19	Large cage, eggs deposited.
July 21	....	....	200	No food or water	July 23, p.m.	3	Medium cage.
July 23	....	....	75	Peaches, cow manure	Aug. 12	20	Medium cage, eggs deposited.
July 27	....	....	200	Cantaloupe, horse manure	Aug. 16	20	Large cage, eggs deposited.
Aug. 10, p.m.	....	....	150	No food or water	Aug. 12, 11 p.m.	2¼	Small cage.
Oct. 22	....	....	700	Milk, banana, manure	Dec. 14	53	Large cage, eggs deposited.

will prevent destruction by cold, and yet with temperatures low enough to prevent activity, and in this way pass the winter. We are inclined to the opinion that the chances of such conditions being found are small and that, although some adults may in this way hibernate, the species is dependent largely on those individuals which pass the winter in the immature stages, or those which continue to breed during the winter. Under Texas conditions we are convinced that this opinion is correct.

To determine the ability of the adults to pass the winter at Dallas, Texas, a cage of screen about ten feet square by six feet high was fitted up with stacks of boards, burlap, paper, etc., for hibernating quarters. Over six hundred adults, about sixty per cent of which were males, were introduced into the cage between November 9 and November 19, 1913. These were mainly newly-emerged adults bred from manure. Food, consisting of bananas, milk, and water, was supplied. Unfortunately the fungus, *Empusæ muscæ*, was unusually abundant during this autumn and the flies in this cage died in great numbers. Probably the majority of them died of this disease. No flies were seen in the cage after November 28, although frequent observations were made during the winter, and in spring a thorough search failed to reveal any living flies in the shelter provided.

At Uvalde, Texas, a similar experiment was conducted, four hundred adult flies being introduced into a large screened cage between December 18, 1913, and January 3, 1914. The flies were supplied with plenty of protection and food. They were observed to seek protection in the rubbish to some extent when the weather became cool. On warm days they resumed activity, feeding, and copulating in some cases.

On January 20, sixty-four adults were found benumbed by cold weather outside of the hibernation material. None of these revived. On January 27, a number were seen to be active in the cage during the warm part of the day. The last adults (two) observed in the cage were seen on January 28. No further activity was noted during the winter and early spring, and no living flies were found on final examination of the hibernation material.

To test the possibility of adults hibernating in buildings where artificial heat is supplied, several hundred flies, bred out in a cage in a small room in the laboratory at Dallas (a great number were also free in the room), were supplied with food, and fire maintained when the weather was cold. The adults began emerging December 30, 1913, from manure infested with larvæ put in the cage December 12. Emergence was allowed to continue for some weeks. The temperature fell to 36° F. on one occasion and once got up to 110° F. for a short time, but usually ran between 50° F. and 75° F. On January 21 larvæ were found which had developed from eggs probably deposited about Jan-

uary 16. On February 21, the last fly in the cage died, thus showing that the greatest possible longevity in this test was fifty-three days.

Turning our attention to our observations and experiments with the wintering of the fly in the immature stages, we find two instances in which we succeeded in carrying the species through in the larval and pupal stages. In one of these tests conducted at Dallas, a large screen cage situated in the country one-half mile from breeding places of the house fly was used. On November 26, 1913, about three barrels of mixed horse manure, cow manure, and straw infested with considerable numbers of larvæ of all sizes and puparia were put into the cage. Some adults began emerging in the cage soon after the manure was introduced. High water covered the manure pile in the cage early in December, but emergence continued after the water subsided until the end of December. No adults were seen to emerge after December 27 until April 16, 1914, when four or five specimens came out, although larvæ were found in the manure in considerable numbers up to March 21. During the latter part of April and early May the manure was again submerged on account of heavy rains, and during this period observations were not made. It seems certain that some larvæ were killed by these inundations. However, on May 26, six vigorous adults were found in the cage. Observations on emergence were not made for some time after this.

We thus have shown that the house fly lived in the larval and pupal stages from November 26, 1913, to May 26, 1914, a period of six months.

It is probable that having this cage placed in partial shade and the inundations to which it was subject retarded the development of the stages, thus accounting for the appearance of adults such a long time after warm weather began. Attention is invited also to the fact that larvæ remained alive, apparently developing slowly during warm periods, from November 26, 1913, until March 21, 1914, the last time the manure was examined. This period covers all of the cold weather usually experienced at Dallas. Had the larvæ, observed on March 21, pupated immediately thereafter and the pupæ produced adults in the usual time, the resulting adults would have found prevailing temperatures sufficiently high to begin reproduction. Hence, we may say that this demonstrates that the larvæ of the house fly may successfully pass the winter at this latitude. If the manure pile had been larger, so as to generate heat, probably the larvæ would have pupated earlier and part of the late winter would thus have been passed in the pupal stage.

At Dallas, the following monthly mean temperatures were experienced during the winter and spring of 1913–14: November, 62.9° F.;

December, 45.0° F.; January, 52.2° F.; February, 43.0° F.; March, 54.5° F.; April, 62.9° F.; May, 71.0° F. The lowest temperatures during the winter were as follows: November, 36° F.; December, 23° F.; January, 25° F.; February, 10° F.; March, 26° F.

A similar experiment was conducted at Uvalde, but with a smaller amount of manure. The manure, consisting of horse dung mixed with straw and infested with larvæ and pupæ, was put in the cage on several different dates, as follows: December 6, December 8, December 9, and December 13, 1913. A total of about two-thirds of a barrel of manure was used. Examinations of the breeding medium made January 14, 1914, and on two subsequent dates, failed to reveal the presence of any larvæ; thus indicating that all had pupated. It is possible, of course, that some larvæ may have been overlooked. Adults continued to emerge throughout the winter except during cold periods. The longest period without emergence was between February 8 and February 16. During this period the daily mean temperature ranged from 39° F. to 61° F. After March 1, from one to nine flies emerged daily up to March 18, when for six days no adults appeared. This, with the exception of March 18 (when the daily mean was 64.5° F.), was a cool period, the daily mean ranging from 42° F. to 59° F. On April 1, 2 and 4, respectively, a single adult emerged and no others appeared after the last mentioned date. During the winter of 1913–14 at Uvalde the monthly mean temperatures were as follows: November, 66.4° F.; December, 54.4° F.; January, 55° F.; February, 54.7° F.; March, 60.1° F. The lowest temperatures during these months were: November, 41° F.; December, 27° F.; January, 23° F.; February, 22° F.; March, 27° F.[1]

Supplementary tests with immature stages were made at Dallas by placing a large number of larvæ and pupæ in boxes of manure under screened cages out of doors. Two thousand larvæ of all sizes, and over one thousand pupæ were used in these experiments. They were picked out of manure, counted and put into small boxes of manure on December 26 and December 30, 1913. Most of the pupæ in these tests produced adults during January and February. On February 28, the last time the manure was disturbed, some larvæ had pupated, but a greater number of larvæ was present. No adults emerged in this cage, and when the final examination was made, on June 6, 1914, no larvæ or puparia were found. Possibly ants destroyed them or the pupæ may have rotted and some of the larvæ may have migrated,

[1] The above temperatures at Uvalde were taken from the Weather Bureau records. Following are the lowest temperatures recorded at the site where experiments were conducted: November, 32° F; December, 27° F;. January, 24° F.; Feburary, 22° F.; March, 28° F.

escaping beneath the cage. The conditions in these tests were not favorable in our opinion for successful wintering, as the amount of manure was small and often it became either too dry or mouldy.

Examinations of chicken manure in poultry houses in mid-winter showed the presence of considerable numbers of house fly larvæ. The conditions in such situations seem especially favorable for the immature stages to pass the winter as the manure generates very little heat, yet being within the chicken house the insects are not subjected to excessive cold. Livery barns furnish somewhat similar conditions, and often great numbers of larvæ are to be found in the cracks of the floors and in corners of stalls. In the South the barns are not heated and the conditions would thus supply uniformly low though moderate temperatures during winter. In the North, where barns are kept heated, there is reason to believe that development and breeding continues during winter in such situations.

Attention has been called in a previous paragraph to the fact that flies emerged during winter at Dallas and Uvalde, and that warm periods occur even in mid-winter which permit of egg deposition by flies in the open.

Our observations on the wintering of the house fly indicate that, in the South at least, winter campaigns against the immature stages are of much importance in control. Destruction of the fly at this time may be easily accomplished by thoroughly cleaning out stables, chicken houses, and animal pens and scattering the manure thinly over fields. Large accumulations of garbage or other breeding media should also receive attention.

President H. T. Fernald: These papers are now open for discussion.

Mr. T. J. Headlee: I would like to inquire if a test has been made to determine the rate of propagation of the screw worm fly and experiments conducted for destroying this fly.

Mr. F. C. Bishopp: We are still working on the biological aspects but have done considerable work in destroying carcasses. We have learned that upwards of one million adult screw worm flies can be produced from one. Our main work of destruction is either by burning or burying. Where we hold the fly down to a minimum, we get very few infestations of living animals. It is a matter of keeping the fly reduced to small numbers.

President H. T. Fernald: We will now listen to a paper by W. E. Britton:

THE ACADEMIC TRAINING OF THE ENTOMOLOGISTS IN COLLEGES AND EXPERIMENT STATIONS OF THE UNITED STATES

By W. E. Britton, *New Haven, Conn.*

In planning this paper, the present writer intended merely to supplement the statistics presented before this association by Dr. L. O. Howard at the Atlanta meeting a year ago and published in the Journal of Economic Entomology, Vol. VII, page 274, June, 1914. It was not intended to discuss the best methods of training, or what should be studied in preparation for entomological work; but simply to ascertain what proportion of these men are college-trained, and what colleges sent them out into the world. At first the scope of the paper included only the entomological workers in the agricultural experiment stations and teachers of entomology in the agricultural colleges. But, there are certain state entomologists, and state horticultural inspectors, as well as teachers in colleges and universities which are not state institutions, all doing creditable work in entomology, and it seemed best to include them.

As the data concerning some of these men were not at hand, a circular letter was sent out October 19, in most cases addressed to the head of the entomological department of each institution, requesting that information be given regarding the academic training of each entomological worker in the department. Of more than sixty such letters sent out, replies were received from about fifty. From *American Men of Science* the writer has been able to obtain data regarding the more prominent entomologists who did not reply, but as a rule could not find there any information about their assistants.

The figures given here are therefore incomplete because the necessary data about a considerable number of men could not be obtained, and these men are therefore not included.

From the start I have avoided names which surely must have been included in Dr. Howard's figures and which would be duplicated if admitted here. Yet I cannot get away wholly from this duplication. It must be remembered that Dr. Riley performed considerable state work before he became Government Entomologist; that his nine Missouri Reports are, and always will be, classics in economic entomology, because his work was so well done and because it was pioneer work; yet Dr. Riley was for so long a time entomologist of the United States Department of Agriculture that we shall always think of him in that connection rather than as state entomologist of Missouri. Likewise Hopkins, Webster, and Quaintance were all engaged in state

work, before joining the Bureau of Entomology, yet they now seem so much a part of the Bureau that we can hardly consider them as belonging elsewhere. None of these men were included in the figures given in this paper. On the other hand such men as John B. Smith, and J. H. Comstock, who were once connected with the Department of Agriculture, and J. M. Aldrich, who has recently joined the Bureau force, have spent so many years of service in the states in comparison with the short period in Government service that they seem to belong to the former instead of the latter and have been so considered.

All present official entomologists and their trained assistants in the various states are also included. Thus such names as those of Dr. Hinds, Dr. Morrill, and Mr. Sanders probably figure in both Dr. Howard's paper and this; and no doubt some have been omitted from both.

Before progressing far, the original scope of this paper was broadened to include certain eminent entomologists connected perhaps with museums, or systematists who though perhaps not holding official positions as entomologists, nevertheless, like Cresson, have made notable contributions to our literature.

In the early days of entomology in this country, it should be remembered that institutions for higher education were few; the system of state colleges which now covers the whole country like a net of lace work has been entirely developed within the past fifty years. Few of our agricultural experiment stations are more than twenty-seven years old. Nearly all of the colleges then in existence were of the classical type; scientific thought and action were just awakening.

It is not strange, therefore, to find that many of the early entomologists were not college graduates, though some of them studied for a time at one or more of the existing institutions. I shall take a few minutes of your time to speak of some of these early workers as well as some of the later ones who have passed from us.

Dr. Thaddeus William Harris, who was the first great economic entomologist of this country, graduated from Harvard University in 1815, and received his M.D. in 1820.

Thomas Say, often called the father of entomology in America, was not a college-trained man.

Dr. B. D. Walsh, first state entomologist of Illinois, graduated from Trinity College, Cambridge, England. Doctor Fitch graduated from the Vermont Academy of Medicine in 1829, and Le Baron also had the degree of M.D. and was probably a graduate of a medical college but I have not been able to find any definite record to that effect. Doctor Le Conte received an M.D. from the College of Physicians and Surgeons, and Doctor Horn from the University of Pennsylvania.

Professor A. S. Packard graduated from Bowdoin college in 1861, and later received the degrees of M.D. and Ph.D. W. H. Edwards, S. H. Scudder and F. H. Snow graduated from Williams College in the respective classes of '42, '57 and '62.

Professor F. L. Harvey graduated from Iowa Agricultural College in 1872; E. A. Popenoe from Washburn College in 1876; D. S. Kellicott from Syracuse University; M. V. Slingerland from Cornell University in 1892, and W. G. Johnson from Stanford University in the same year, though having previously studied at Cornell, and at Ohio State University.

Messrs. Thomas, Uhler, Lugger, Lintner, John B. Smith, and J. A. Grossbeck apparently received no college training, though Thomas, Uhler, Lintner and Smith were given honorary degrees.

Among the older workers yet with us Professor Chas. H. Fernald studied at Bowdoin College, receiving an M.A. in 1871; Professor J. H. Comstock graduated from Cornell in 1874. Dr. Geo. Dimmock of Springfield, Mass., graduated from Harvard in 1877. Samuel Henshaw and E. T. Cresson were not trained in colleges though Henshaw received an honorary A.M. from Harvard in 1903.

The card catalogue upon which this paper is based contains 306 names. Following Dr. Howard's arrangement in grouping them according to the part of the country in which the colleges are situated and adding Dr. Howard's figures for comparison, the results are as follows:

	Outside of Federal Service	Federal Service [1]	Total
From colleges in the Eastern States	117	113	230
From colleges in the Central States	121	63	184
From colleges in the Western States	28	31	59
From colleges in the Southern States	15	23	38
Total American Institutions	281	230	511
Total Foreign Institutions	3	12	15
No colleges	22	18	40
	306	260	566

Of course the efficiency of the entomological worker depends far more upon the personal equation of the man than it does upon his college training. No college course can quite take the place of actual experience in field and laboratory. The fact that many entomologists without college training have become eminent, simply means that these men had the other necessary qualifications and succeeded in

[1] Figures taken from paper of Dr. L. O. Howard, Jour. Econ. Ent., Vol. VII, page 277.

College Training of Entomologists

Name of Institution	Not in Federal Service					Federal Service[1]	Grand Total
	Student	Bachelor's Degree	Master's Degree	Doctor's Degree	Total No. Men		
Alabama Polytechnic Institute		1			1	2	3
Allegheny College						2	2
Amherst College		1		1	1		1
Augustana College		1	1	1	1		1
Baker University	1				1		1
Baldwin University		3			3		3
Beloit College						1	1
Bowdoin College		1	1		2	1	3
Brooklyn Polytechnic Institute		1			1		1
Bucknell College	1				1	1	2
Buchtel College	1				1		1
Butler College	1				1		1
Campbell College		1			1		1
Clark University		1	1	2	2	2	4
Clemson College	4	1			5	1	6
Colgate College		1	1		1		1
College of Physicians and Surgeons				1	1		1
Colorado Agricultural College	1	5	1		7	10	17
Columbia University	1		1	1	2	2	4
Connecticut Agricultural College		5			5	1	6
Cooper Medical College					1		1
Cornell University	20	24	11	14	63	26	89
Dartmouth College		3			3	1	4
Delaware Agricultural College						1	1
De Pauw University		1			1		1
Florida Agricultural College						2	2
Georgia State College of Agriculture		1			1		1
German American Normal College	1				1		1
German-Wallace College		2			2		2
Harvard University	6	7	2	5	18	7	25
Hillsdale College		1			1		1
Illinois State Normal University	2				2		2
Iowa State Agricultural College		8	6		9	1	10
Iowa State University	1		1		1	4	5
Iowa Wesleyan University		1			1		1
James Milliken University		1			1		1
Jefferson Medical College						1	1
Johns Hopkins University	2			3	5	1	6
Kansas State Agricultural College		6	5		9	5	14

[1] From Dr. Howard's paper, Jour. Econ. Ent. Vol. VII, 279.

College Training of Entomologists—*Continued*

Name of Institution	Not in Federal Service					Federal Service[1]	Grand Total
	Student	Bachelor's Degree	Master's Degree	Doctor's Degree	Total No. Men		
Kentucky State University	1				1	1	2
Keuka College	1				1		1
Knox College		1	1		1		1
Lafayette College		1			1		1
Maryland Agricultural College	1	2	1		4	4	8
Massachusetts Agricultural College	1	25	4	7	27	36	63
Michigan Agricultural College	2	10	6		12	7	19
Middlebury College		1			1		1
Mississippi Agricultural College						3	3
Montana Agricultural College	1				1	1	2
New Hampshire Agricultural College		3	1		4	2	6
North Carolina Agricultural College	2				2	1	3
Ohio Northern University		1			1		1
Ohio State University	6	18	10	2	33	17	50
Ohio Wesleyan University						1	1
Oklahoma Agricultural College	1	1			2	1	3
Ontario Agricultural College		2			2	6	8
Oregon Agricultural College		1	1		2		2
Otterbein University		2			2		2
Pennsylvania State College						5	5
Pomona College		3			3	2	5
Princeton University		2	1		3		3
Purdue University		1			1		1
Randolph-Macon College						1	1
Rutgers College		2	1		2	1	3
South Dakota Agricultural College		2	1		2		2
Stanford University	1	6	2	2	8	7	15
Swarthmore College		1			1		1
Syracuse University		1			1		1
Texas Agricultural College	1	1			2	2	4
United States Military Academy	1				1		1
University of California		5	2	1	8	1	9
University of Chicago	1		1		2	2	4
University of Colorado	1	1			2	1	3
University of Idaho						2	2
University of Illinois	3	8	2	6	15	5	20
University of Indiana		4	3	1	5	1	6
University of Kansas	2	13	10	1	17	5	22
University of Louisiana						2	2

[1] From Dr. Howard's paper, Jour. Econ. Ent. Vol. VII, 279.

College Training of Entomologists—*Continued*

Name of Institution	Not in Federal Service					Federal Service [1]	Grand Total
	Student	Bachelor's Degree	Master's Degree	Doctor's Degree	Total No. Men		
University of Maine		1	1		2	1	3
University of Michigan	1				1	1	2
University of Minnesota	1	3	2		5	2	7
University of Missouri		5			5		5
University of Montana						1	1
University of Nebraska	4	4	1		8	7	15
University of Nevada					1	1	2
University of North Dakota						1	1
University of Pennsylvania	1	2		4	6	6	12
University of South Dakota						1	1
University of Tennessee		1			1	2	3
University of Texas		2	1		3	2	5
University of Utah						3	3
University of Washington		1	1		1	2	3
University of West Virginia						2	2
University of Wisconsin	1	1		1	3	1	4
University of Vermont		1			1		1
Ursinus College		1			1		1
Utah Agricultural College		3			3	2	5
Vanderbilt University	1				1		1
Virginia Polytechnic Institute		3	2		3	4	7
Wabash College	1	1			2		2
Washburn College		1	1		1		1
Washington & Jefferson		1			1		1
Washington University (St. Louis)						1	1
Wesleyan University	2	1			3		3
Western Reserve University	1		1		2		2
Williams College	1	5	2		6		6
Worcester Polytechnic Institute	1				1		1
Yale University	3	1	1	3	8	5	13

spite of the lack of it. With it their success would have been even greater.

Realizing that men frequently receive their undergraduate training at one institution, then go to another for graduate instruction; that some attend colleges but do not graduate; that it would be of interest to learn which institutions conferred the bachelor's, master's and doctor's degrees possessed by our entomologists, the above arrange-

[1] From Dr. Howard's paper, Jour. Econ. Ent. Vol. VII, 279.

ment was finally adopted in the list of colleges and the number of entomologists who have sprung from them.

If we combine the number of different men with the similar figures given last year by Dr. Howard for the Bureau of Entomology, as has been done in the last two columns in the table, a better general survey of the subject will be obtained, despite the fact that duplications undoubtedly occur. These statistics are given in the accompanying tables.

Of the institutions attended by the entomologists discussed in this paper, the Massachusetts Agricultural College leads in the number of 25 bachelor's degrees conferred. Cornell follows with 24; Cornell has given fourteen doctor's degrees, Massachusetts Agricultural College seven. As regards the master's degree, Cornell has conferred eleven, Ohio State Univeristy nine, and four have been given by the Massachusetts Agricultural College. In the number of entomologists who have studied for a time without receiving a degree; Cornell also leads with twenty, and is followed by Ohio State University with eight. Cornell also is far in the lead, in the number of different entomologists who have studied within her walls. The following institutions lead the others in the number of entomologists receiving instruction there:

	Men outside of Federal Service	Federal Service	Total
Cornell University	63	26	89
Mass. Agricultural College	27	36	63
Ohio State University	33	17	50
Harvard University	18	7	25
University of Kansas	17	5	22
University of Illinois	15	5	20
Michigan Agricultural College	12	7	19
Colorado Agricultural College	7	10	17
Stanford University	8	7	15
University of Nebraska	8	7	5

In the years to come it will be even more essential than in the past that the entomologist receives a good undergraduate college training as a foundation upon which to build the superstructure of his professional life work.

It is particularly gratifying, today, to learn that so large a number of institutions are engaged in supplying the need.

President H. T. Fernald: If there is no discussion on this paper, we will now adjourn.

Adjournment 4.30 p. m.

Morning session, Tuesday, December 29, 1914, 10.00 a. m.

PRESIDENT H. T. FERNALD: The meeting will please come to order.

VICE-PRESIDENT HERRICK: I move that the discussion of the presidential address be deferred until later in the session. Carried.

PRESIDENT H. T. FERNALD: The first paper on the program will be read by Mr. A. G. Ruggles.

LIFE HISTORY OF OBEREA TRIPUNCTATA SWED.

By A. G. RUGGLES

Division of Entomology, Department of Agriculture, University of Minnesota

On June 14, 1911, the Superintendent of Parks of St. Paul, Minnesota, asked for help in diagnosing and combating a pest on the elm which was new to him. All the trees along one of the finest avenues in St. Paul were found with numberless dead leaves hanging from terminal twigs. The ground was strewn with leaves, reminding one of the fall season. In order to keep the lawns and boulevards in shape, the leaves had to be raked up each day and the insect was proving a nuisance if not a serious pest.

No adult insects capable of doing this damage were seen then nor upon careful search later. As the eggs found seemed quite fresh, it is possible that the beetles may have been working at night or that they were all through ovipositing and had disappeared. In the spring of 1912, no adults nor egg-laying injuries were seen. Owing to a temporary absence from the state in 1912–13, no adult insects causing the damage have been taken in the field, up to the present time. The literature available gave only two references to an insect that might have been responsible for this damage.[1] These referred to *Oberea ulmicola* Chittenden. The work of this insect and the one in question corresponded very closely and since that time, in our notes, this insect has been referred to as *Oberea ulmicola.* Observations were made daily for a while, and weekly later, for the entire growing season of 1911 and the entire season of 1912. During my absence from the state in 1912–13, my assistant, Mr. George Peake, took care of the collected specimens and brought in new ones from the field from time to time. In January, 1913, under insectary conditions, and in May, 1913, under natural conditions, the larvæ pupated, the adults emerging ten days to two weeks later.

Since returning to the state, no opportunity occurred to study this

[1] Forbes, S. A. Twenty-fourth State Entomologist's Report of Illinois, 1908, Bull. Ill. State Lab. Nat. Hist. Vol. VII, Art. 1, pp. 10 and 11.

collected and reared material until November of the present year, when the beetles were sent to Dr. Chittenden for identification. He pronounced the beetle to be the common *Oberea tripunctata* (Swederes). The literature on *O. tripunctata* until a few years back referred only to the work of the insect on raspberry and blackberry. Hence, I surmise, according to a statement of Dr. Chittenden's, these were really references to *O. bimaculata* (Oliv.). In 1908, Forbes [1] mentions this species as being found working on elm and in 1911 as working on dogwood. As this seems to be a new pest for Minnesota and as the life-history differs from that given by other observers, it seemed worth while to bring it to your attention.

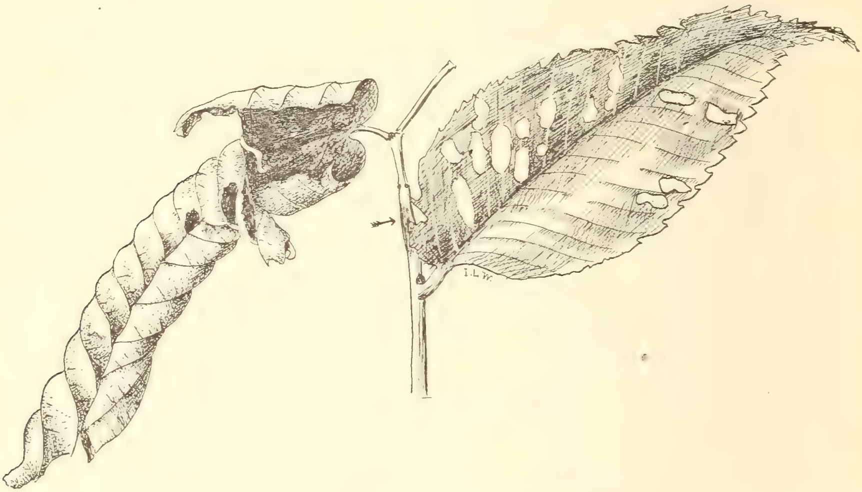

Fig. 1. Shows work done by adult of *Oberea tripunctata* and the relative position of the egg. (Somewhat reduced.)

The Work of the Adult

The elm leaves, as shown in Fig. 1, were found on infested twigs and at the time the work was suspected to be that of the beetle in question. (This of course has never been proved.) Many twigs were found completely girdled in several places, evidently due to more than one beetle ovipositing. Below the last complete girdle, there was seen a double irregular slit, evidently made by the two ovipositors not quite coinciding, which extended 7 to 8 mm. down the stem to an incomplete girdle. Half way between these two points, the egg was inserted under the edge of the slit bark.

[1] Forbes, S. A. *Loc. cito.* and Twenty-sixth State Ent. Rep., Illinois, 1911.

The Egg

The egg is 2½ mm. long and 0.7 mm. in width; cylindrical, with round ends, smooth and of a yellowish tinge. Many eggs were found on one stem, each in its characteristic position, but all the eggs between the complete girdling next the main stem and the end of the twig soon perished. Fig. 2 shows the methods of placing the egg in the twig. The arrow in Fig. 1 and the x in Fig. 2 show the position of the egg.

Larvæ and Work

The eggs began to hatch June 21, just one week after my first observation, and no more eggs were found after June 28. The entrance hole of the larva was just below the lower end of the egg. In the majority of the burrows examined, the larvæ first tunneled upward and later returned to continue the burrow downward. Many perished by emerging at the girdled end. This may be due to their inability to turn around after emergence or possibly due to attacks of an enemy. Along the burrow, at short intervals, 6 mm. or more, the larva made holes through the bark or through an aborted bud out of which it pushed its borings. Up to October 30, 1911, the longest burrow made was 75 mm. The majority of the burrows, however, were much shorter. The larvæ at this time measured 5 mm. in length and had a head measurement of 0.6 mm. This, according to the theory of head measurement, would place the hibernation period in the third instar. By the last of July, 1912, practically all the larvæ had reached the last stage, having a head measurement of 1.2 mm. In September, 1912, some burrows were six inches and more in length and in the terminal portion of the burrow, the larva hibernated. In Minnesota, therefore, it takes two years for this beetle to complete its life-cycle.

In wood-boring insects, it is very difficult to find moulted skins in the burrows and practically, therefore, impossible to tell the number of instars. I have been doing some work on the head measurement of these wood-boring insects, and a few species of wood-boring beetle larvæ in all their stages have been examined. The head measurement appears quite constant for a given period which we believe would correspond to the length of an instar, and therefore, this measurement is preferred to merely length measurements which are sometimes given with descriptions of larvæ. For *Oberea tripunctata* larvæ, the following measurements and descriptions are given:

First Instar.—Head measurement, .36 mm.; length, 0.8 mm. to 2.6 mm. The young larvæ are lemon-yellow in color, at times having an orange cast. The anterior part of the head and mandibles are a very

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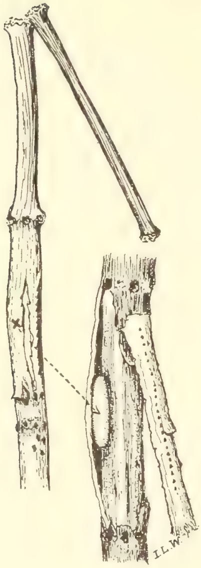

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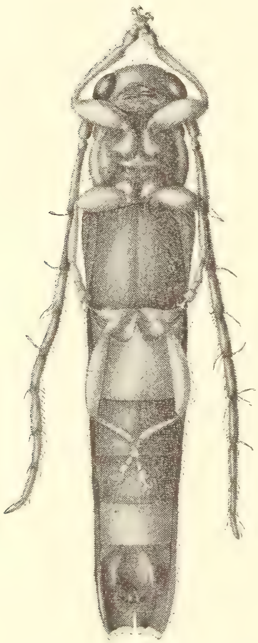

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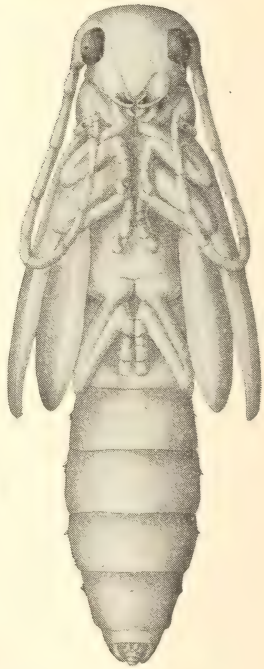

Fig. 2. Showing detailed work of adult and position of egg (x4)
Fig. 3. A young larva soon after hatching (x6)
Fig. 4. A lateral view of a larva showing the ventral and dorsal ridges (x6)
Fig. 5. A pupa (x6)
Fig. 6. A ventral view of an adult (x6)

dark brown; the labium is light-colored and seemingly not chitinized. The posterior area of the dorsal portion of the head is light-yellow, resembling the thorax in color. A larva just after hatching is only a little over twice as long as the width of the widest part. The segments are closely set together. Later, as the larva grows, these separate, as in the other instars. The shape is typically Cerambycoid; the thoracic segment immediately caudad of the head having the largest diameter of all the segments, while the following segments gradually decrease in size until the penultimate segment is distinctly smaller and the anal segment distinctly smaller than the preceding. On a distinct anal ridge on the caudal portion of the first thoracic segment is a somewhat triangular area in which are short hairs or bristles giving the appearance of shagreening. This area is very noticeable in all the succeeding instars. Ten transverse rows of short bristles are seen in each shagreened area. The third, fourth and fifth rows are composed of larger bristles while the last few rows are very small and almost inconspicuous.

A number of short, stiff hairs arise from the head and on the lateral margin of each thoracic and abdominal segment are found three to six hairs somewhat longer than those found on the head. The posterior margin of the caudal segment is beset with numerous hairs. Toward the end of the instar, the segments are plainly distinguished and dorsal ridges as described in instar number two begin to appear.

Second Instar.—Head measurement, .45 mm., length, 3 mm. to 5 mm. The last three or four rows of inconspicuous bristles in the shagreened area of the thorax are curved. On the dorsal surface of each of the abdominal segments, particularly the second to the sixth, there is a distinct, flattened, ridge-like area. These look like tubercles in a side-view. (Fig. 4.) The hairs are the same as for the first instar.

Third Instar.—Head measurement, .66, length, 4.5 mm. to 10 mm. Besides the characteristics mentioned for the other instars, the segments of the larvæ have a decided moniliform appearance, due to the prominence of the dorsal ridges and the swollen lateral margins of the segments. The ventral surface of each segment has also a prominent ridge.

Fourth instar.—Head measurement, .8 mm., length, 10 mm. to 22 mm. The dorsal ridges are very regular and on the flattened surface, indistinct shagreening, divided into two distinct lines, each separated by a median line, may be detected. The ventral protuberances have minute tubercles and hairs on the surface.

Fifth Instar.—Head measurement, 1.2 mm.; length, 19 mm. to 25 mm. The other characters are very similar to those in fourth instar.

Pupa

Pupæ were found only in the second year after the eggs were found. In the field, they were normally found in May. In two or three weeks, the adults emerged. They lie naked in the extremity of the burrow. Length, 13 mm., width, 3 mm.; color, uniformly white, at first, later changing to light yellow. The compound eyes are dark-brown quadrangular areas on the ventral part of the head, close to the base of the antennæ. On the anterior portion of the head, between the base of the antennæ, are two sets of hairs, each set containing two hairs, one hair usually twice the length of the other. The distal half of the mandibles are light brown in color and the entire area between the mandibles is filled with the sub-triangular clypeus.

The antennæ are quite prominent, extending to the base of the hind femora when they curve forward to the base of the front legs.

Adult

Like all the species of Oberea, this is a slender form; length, 12–14 mm., width, 1.5–2 mm. The head, antennæ, and middle and outer and inner margins of the elytra are black. The central area of the elytra, running three-quarters of its length, is usually orange in color. The head, elytra, and thorax are feebly punctate, the pits on the elytra being the more conspicuous. A dense gray pubescence is found over all these regions. The thorax is yellow or orange in color, and on the dorsal region has three black callosities. The smaller median one lies in front of the scutum, while the two larger spots lie one on each side of the median line.

One of the distinguishing characters of the species is the banding of the ventral segments. The thoracic segments are black with perhaps the exception of the part of the metathorax where the yellow legs are attached. The first segment of the abdomen is yellow, the next two are black, the following segment is yellow, while the caudal segment is black. A slight overlapping of the segment areas by the yellow bands is often noticed. The yellow portions on some specimens are often replaced by dark orange. The proximal portions of the legs are yellow or orange, the tips being dark brown or black.

Parasitism

As mentioned previously in the paper, many larvæ perished while in the burrow toward the cut end of the twig, due possibly to some predaceous parasite. Many times in later stages, the burrow was found empty with evidences that the larvæ had been attacked by

parasites. For various reasons none were reared. In hunting for larvæ, the presence of empty burrows was very noticeable, so much so that in the notes taken in 1911–12, it was estimated that there must be from 50 to 80 per cent of parasitism.

Preventive Measures

At the time of the outbreak, it was recommended that all the infested twigs should be cut out and burned, or that if the tree was trimmed and pruned properly, the insects would be disposed of. This was done, to a large extent, and as we heard of no outbreak in 1913, the trimming must have been effective.

Mr. J. M. Aldrich: I would like to ask Mr. Ruggles if he reared any parasites?

Mr. A. G. Ruggles: We did not rear any parasites. I was away so much that it was impracticable to attempt to do this.

President H. T. Fernald: We will now listen to a paper by C. Gordon Hewitt.

THE BROWN-TAIL MOTH IN CANADA

By C. Gordon Hewitt, *Ottawa, Can.*

(Paper not received in time for publication.)

President H. T. Fernald: This paper is now open for discussion.

Secretary A. F. Burgess: Last spring, through the courtesy of Dr. Hewitt, I had an opportunity to visit New Brunswick and Nova Scotia and go over a part of the infested territory. This made it possible for me to see the difficulties under which his men were obliged to work during the long cold winter which is usually accompanied by deep snow.

The territory is not provided with good transportation facilities, particularly in New Brunswick, and this makes it very difficult for the men to do the work.

I was greatly impressed with the conscientious and hard work which had been done by the field men in that territory. Dr. Hewitt has indicated the distribution of the brown-tail moth in Nova Scotia and New Brunswick, the outer line representing the territory found infested in the winter, 1913. In the spring of 1914, we made a trip through the southern part of New Brunswick from St. John to St. Stephens; thence to Woodstock, New Brunswick, and Houlton, Maine, and returned to St. John.

Another day was spent in the Annapolis Valley in Nova Scotia. During this trip, I did not see a brown-tail moth web, although a great many susceptible trees were hastily examined. This indicates that good work had been done by the field men. It also indicates the difference in condition of infestations in that territory from what is found in some of the New England States.

Dr. Hewitt mentioned a series of experiments that are being carried on by his assistants to determine the relation of temperature to the successful hibernation of brown-tail caterpillars. Last winter, particularly in the northern part of the infested territory in New England, large numbers of the brown-tail moth caterpillars died in the webs. Although we do not know accurately the exact causes, we believe that temperature and humidity were very important factors.

For several years, some experimental work of this sort has been carried on by the Bureau of Entomology and by some of the states, particularly New Hampshire, and some general conclusions have been reached in regard to the effect of temperature on hibernation. The difficulty is the impossibility of securing accurate temperature records so as to determine the degree of temperature which will cause winter killing and whether fluctuations are important in this respect.

We have come to the conclusion in our work that it is necessary to have a continuous temperature and humidity record at the locations where periodical collections are made during the winter. Experiments are being conducted this year along this line, stations having been secured at approximately sea level and at an altitude of about one thousand feet. Continuous records are being taken at these stations and collections of webs secured periodically and examined to determine the condition of the caterpillars.

Hearty coöperation has existed between the Bureau of Entomology and the Dominion Entomologist in connection with the introduction of parasites into New Brunswick and Nova Scotia. In cases where the parasites of the gipsy moth and the brown-tail moth attack more than one host, it is possible to attempt a colonization of the parasites before these pests become established. This work, however, is largely experimental.

We have coöperated during the past summer with Professor Webster, who has charge of the Cereal and Forage Crop Insect Investigations for the Bureau of Entomology. He supplied a man during the summer to make collections and we have rendered such assistance as was possible in securing *Compsilura* and *Calosoma* for shipment to New Mexico in order to test the value of these species as an enemy of the range caterpillar.

We have colonized parasites in all the New England States this

year and have carried on very successful coöperative work with Professor O'Kane in New Hampshire.

Mr. W. E. Britton: Knowing as we do the general tendency of the brown-tail moth to spread toward the north and east, I think it would be interesting if Dr. Hewitt would explain why the southern end of Nova Scotia is not generally infested.

Mr. C. Gordon Hewitt: Answering these inquiries as they are made, I would like to say in reference to Mr. Burgess' remarks concerning the effect of humidity, that we find in Nova Scotia, judging from our own results along here (indicating on the map), that the average minimum temperature is higher than the minimum temperature in the interior of New Brunswick. Owing to the occurrence of greater humidity along the shore of the Bay of Fundy than in New Brunswick, we find a greater percentage killed at a higher minimum temperature. It is very evident that humidity exercises a very great influence along this region in Nova Scotia (indicating the Annapolis Valley), where the fogs are effective.

In regard to Dr. Britton's inquiry as to why the central region of the eastern part of Nova Scotia is not infested, I cannot explain that except in the absence of the chief food plants. This portion of Nova Scotia (indicating) has a very peculiar geological formation. It is largely coniferous and unsettled except here and there. Such occupied lands are usually infested, but we never found any webs in the scouting trips which have been made across the forest and lake region. The large flight in 1913 resulted in the infestation of the southeastern region including Shelburne County. We had observations made on Sable Island by the lighthouse people, who collected and submitted for examination all the moths they could capture at the light. We did not find a single brown-tail moth but we found moths of the army worm in these collections.

A Member: What is the minimum temperature in New Brunswick?

Mr. C. Gordon Hewitt: The minimum temperature in New Brunswick in the infested region last year, I think, was, so far as our records show, 30.5 degrees below zero at St. Stephens. We found in Nova Scotia that one hundred per cent of the larvæ were killed at a number of points where the temperature went to 22 degrees below.

A Member: In New Hampshire as high as 95 per cent have been found alive at a temperature of 30 degrees below.

Mr. C. Gordon Hewitt: We found them in New Brunswick with minus 30.5 degrees Fahrenheit temperature.

President H. T. Fernald: We will now pass to the next paper by Mr. C. H. Hadley, Jr.

CONTACT SPRAYS FOR BROWN-TAIL CATERPILLARS

By C. H. Hadley, Jr., *Durham, N. H.*

(*Paper not received in time for publication.*)

Secretary A. F. Burgess: Mr. Siegler, one of Professor Quaintance's assistants, carried on some experiments with insecticides to determine their effect on brown-tail moth caterpillars. I think his results might be interesting.

Mr. E. H. Siegler: Under the direction of Mr. Quaintance, experiments with various miscible oils, alone and combined with nicotine sulphate, were conducted in Maine and Massachusetts during the season of 1913. The first test of the spray materials was directed against the brown-tail nests and later, when the larvæ were emerging from their nests in maximum numbers, a second spray application was made.

A few days following the spraying of the nests, the nests were cut and removed to the laboratory at Melrose Highlands, Mass. Although the nests had been thoroughly drenched with the spray materials, the larvæ emerged apparently unaffected. The structure of the winter nests makes it difficult for a spray material to penetrate sufficiently to kill the insects within. Furthermore, with large trees, it is difficult to thoroughly drench the nests unless a large amount of spray material is used.

As soon as the brown-tail larvæ were emerging from their nests in maximum numbers, they were sprayed with the miscible oils and nicotine solutions. This work was carried out both in the field and laboratory. In all instances the larvæ were thoroughly drenched. The results were not satisfactory. Owing to the hairy covering of the larvæ, the spray materials stood in small drops at the extremity of the hairs, apparently not coming in actual contact with the body of the larvæ. The only material which gave satisfactory control was pure kerosene. This could not well be used owing to the probable injury it would cause to the host plant.

Mr. C. H. Hadley, Jr.: The experiments which we conducted were on small trees and in some cases we used eight quarts of material to a single tree. So far as possible, we aimed to drench the caterpillars in order to give the insecticide a good opportunity to penetrate. It is doubtful if we would use as large an amount of material in our spraying operations.

President H. T. Fernald: Is there any further discussion?

Mr. T. B. Symons: I move that we now take up the discussion of the President's address. Carried. Vice-President Herrick takes the Chair.

Vice-President Herrick: Personally, I was much impressed with two points—one the emphasis laid upon the desirability of more exhaustive studies on the life-history and habits of insects. That I think has been emphasized by certain results obtained lately. I think many of us have felt that the extensive work of Professor Slingerland on the peach-tree borer precluded the necessity for any further work on this pest. I understand, however, that further work on the habits and life history of this insect by Professor Scott has enabled him to develop a method of control which is very efficient. This emphasizes the need of further study of the life-history and habits of other insect pests.

Another point emphasized was more careful studies of insecticides. Undoubtedly Dr. Felt has brought together a good deal of proof that miscible oils are injurious to trees under certain conditions, but during the last two or three years we have applied miscible oils to a great many trees at certain stages, and in no case found injury to these trees. Unfortunately, we do not know just the conditions that bring about injury in some cases and no injury in other instances. This, it seems to me, emphasizes the need of more careful and thorough study of insecticides.

I hope there will be further discussion of this address.

Mr. J. G. Sanders: I was deeply interested in one point brought out by the President regarding the necessity for very careful study of all stages of the life history of economic insects, which was emphasized by the speaker. In our work on the control of the onion maggot in Wisconsin during the past four years, and in working up the literature relating to the control of this species, we have noted a large number of remedies recommended for the control of the onion maggot, numbering I think over sixty. Practically all of these remedies have been recommended for the destruction of the egg or larva already placed on or adjacent to the onion plant, while a few methods were intended as repellents against the adult fly. It seems that no effort had been put forth to kill the adult fly before oviposition.

In a careful study of the life-history of the onion maggot it was determined that a period varying from 10 to 14 days elapsed after the emergence of the adult female before fertile eggs were deposited. It seemed that if an effective means of killing the adult fly during this period could be obtained, it might possibly prove an effective control for this pest. We have determined an effective poison bait spray which works satisfactorily with the adult fly and seems to be a very practical and effective control for the onion maggot, in some cases to the extent of 95 per cent to 98 per cent, while a check plot adjacent was injured to the extent of 75 per cent.

The poison bait spray used is composed of five grams of sodium arsenite dissolved in a gallon of boiling water into which is thoroughly mixed a pint of New Orleans molasses. This bait is applied as a coarse spray of large drops once a week in strips across the onion field throughout the summer. The results show almost perfect control at a cost not to exceed 50 to 75 cents per acre for the summer treatment.

The results of this treatment serve to emphasize this point in the address of our President relating to a more careful and thorough study of all stages of our economic insect pests with a view to finding the most vulnerable stage in their life history. I really believe that more attention should be given to the destruction of the adult insects whereever it is feasible.

Mr. E. P. Felt: I think most of us would heartily endorse what our President conveyed in his message of yesterday, and while I do not care to discuss the address as a whole, I would like to refer to two matters, namely, the study of life zones and the prediction of insect outbreaks.

We are located next to Massachusetts, and if we had desired to do so, could have brought a map of New York State showing very nearly a duplication of the conditions described in Massachusetts. More than that, we are using this general knowledge of life zones in our recommendations and are finding in that connection some interesting and important economic applications. We began studying life zones in a general way in 1898, and while we have not given a large amount of time to the investigation, it is a matter which has been constantly in mind. At the outset we made some temperature calculations, and, among other things, found probable extensions of the upper austral zone almost to Lake George and Lake Champlain. We have in New York State, certain insects rather closely confined to this zone. This is fairly well marked in the case of the San José scale and the elm-leaf beetle. Five or six years ago the latter began to be injurious at Glens Falls (altitude 300+ feet, soil sandy), a locality considerably north of the usual recognized boundary of the upper austral life zone. At that time I gave an opinion in the belief that this locality lay in the transition zone, to the effect that there was a fair chance of the insect not proving injurious. Subsequent developments showed that this insect was injurious not only there but also at Ticonderoga (elevation about 200 feet) on Lake Champlain.

An important point in this connection is that the northern extension of the upper austral life zone and of insects associated therewith, may be brought about in two ways. In the first place we have a great prolongation northward of land only a little above sea level, and in the second, and fully as important in some respects, is that north from

Albany there is an extensive sandy area. Land of this character absorbs large amounts of heat in the daytime and gives it off at night, thus preventing during the active growing season, dangerously low night temperatures and permitting a greater extension of the upper austral life zone than would be possible otherwise. For example, the well-known southern *Sphecius speciosus* has been taken for several years in succession on the sandy plains west of Albany.

We have endeavored to trace the connection between climatic conditions and insect outbreaks, because we realize that if we could say to our farmers: "Certain weather conditions are favorable or unfavorable for the development of injurious insects," we had something of practical value, provided it was not carried too far. We are satisfied that abnormally low temperatures continued late in the season mean favorable conditions for outbreaks of apple plantlice.

Another interesting matter is in connection with the elm-leaf beetle. In 1912 and again in 1914, in a little village (Nassau) fourteen miles from Albany and having an elevation of about 400 feet, we have had a large number of elms under personal observation. In the early spring of both seasons, elm-leaf beetles appeared in numbers rather abundantly and deposited many eggs, a condition preliminary to extensive and serious injuries, which latter failed to develop as expected. We carefully examined the temperature records for the month of June, covering a period of ten years, and found in the case of the two years mentioned above, a marked decrease in the average temperatures during the middle ten days of the month, namely June 11 to 20 inclusive. This is a time when, under normal conditions, in our latitude, egg-laying should be at its maximum. It is necessary, in our estimation, that there should be a coincidence between the period of low temperatures and the time when oviposition is at its height, otherwise these vital functions, such as the deposition of eggs, their hatching and the development of the young larvæ, may simply be delayed rather than inhibited. Under our conditions it would appear that when the sum of the maximum and minimum temperatures (F.) for a ten-day period for or about the middle of June does not exceed 1,250, the probabilities are that egg-laying will be checked and that an unusual mortality will occur in both eggs and young grubs. This is simply a tentative proposition and is a line of investigation which must be followed with caution.

A little farther east from Nassau, at an elevation of approximately 800 feet, and surrounded by ridges running close to 2,000 feet, there seems to be relatively little injury from this insect, presumably due to the fact that the minimum spring temperatures prevent a normal and vigorous development.

This may possibly be applied more generally as soon as we recognize the vital factors and realize the connection between the period of maximum oviposition and adverse climatic conditions.

Vice-President Herrick: I would like to ask Dr. Felt if he knows the altitude of Ticonderoga?

Mr. E. P. Felt: Approximately 200 feet.

Mr. C. Gordon Hewitt: I should like to add a word of praise to what has been already said regarding Dr. Fernald's presidential address, so full of suggestion and admirable counsel. We find especially in Canada the truth of his remarks in regard to the necessity of working out more carefully and completely the life-histories of many known injurious insects. We have not had many workers in the past and have found it necessary to rely very largely on the results of investigations obtained in the United States. We are now finding on investigation that in many instances we are mistaken and that we have not been advising the best methods in the control of some of our common insects; therefore, I appreciate very fully the significance of the statement that further intensive work is necessary as all will agree.

I was much interested in the second part of the address, in regard to the new fields of work, especially those which concern us, for example, relation of temperature to insects. The factors governing the distribution of insects concern us very closely, especially in regard to the question as to what insects now occurring and injurious in the United States are likely to find congenial conditions for injurious activity when they arrive in Canada. I think from the fact that we have not found so many destructive insects as we might be led to expect would appear to indicate that certain species have reached the northern limit of their destructive powers.

I was especially interested, too, in the President's remarks on the necessity of our becoming more familiar with the relation of food to reproduction and longevity. There was one point that Dr. Fernald did not mention (he naturally could not cover the whole ground of new work), and that is the desirability of securing information covering or bearing on the relations of the Chemotaxis. The recent excellent results obtained by Messrs. Dean and Hunter and others in the use of poisoned bran, made attractive by lemon and other fruits, is a long step forward. Dr. Tragardh in Sweden and Mr. Howlett in India have given us much information regarding the attractiveness of various chemical substances. It is certain that this line of inquiry will open up a new field of immense practical value in the control of insect pests.

We all appreciate, I am quite sure, the great importance of a general knowledge of foreign insects. As is well known to all the members

here, the British Empire has been endeavoring to overcome our lack of knowledge of the insects of foreign countries, and in 1912 the Imperial Bureau of Entomology was formed in London, one of the first and chief functions of this Bureau being to collect information regarding insect pests and to distribute that information to the various British countries and possessions. Most of the members in this meeting are able through the *Review of Applied Entomology* published by the Imperial Bureau to make use of that information. This is one of the chief steps in the direction of making us better acquainted with the insect pests of foreign countries.

Mr. W. E. Britton: I have been much impressed with the President's address, and many of the points which he has mentioned are certainly deserving of further study. In regard to the elm-leaf beetle, however, I may state that formerly I believed as he does—that the danger of its doing much injury in the higher altitudes was slight. During the past few years, however, I have changed my mind. During 1914, especially, it has caused serious injury in Winsted, Norfolk, Canaan and other points about 1,000 feet above sea level. On the other hand, there was very little injury along the coast where the insect has caused serious damage for more than 20 years.

With these introduced insect pests, it seems to me that we must allow them considerable time in which to find their economic level; that we may find it necessary to revise our first opinions because conditions may modify the habits or severity of a pest. It is hardly safe to draw conclusions or to go very far in generalizing about the distribution causes, until the species has been present for a long time and its status as a pest has become established.

Secretary A. F. Burgess: A great many statements have been made that certain insects, particularly foreign species, will become a pest in this country only in certain regions and on particular food plants and this information has been published quite frequently.

In the case of the brown-tail moth, for instance, it was, years ago, very common on elms in the worst infested region in New England. At the present time the number of webs found on elm trees is rather small. It was generally stated a number of years ago that the elm-leaf beetle was a city insect but the fact is that we find it in the country in New England almost everywhere elm trees grow. The same has been published concerning the leopard moth in regard to its being a shade tree or city insect, but it is very possible that this pest may later on do great injury in woodland.

It seems to me, as Dr. Britton has said, you cannot lay down a law concerning new insects until we have had considerable experience with them.

VICE-PRESIDENT HERRICK: If there is no further discussion, we will proceed with the program. President H. T. Fernald resumes the Chair.

PRESIDENT H. T. FERNALD: The next paper on the program will be read by E. P. Felt.

FUMIGATION FOR THE BOX LEAF MINER

By E. P. FELT, *Albany, N. Y.*

The Box leaf miner, *Monarthropalpus buxi* Lab., has become well established on Long Island and is seriously injuring ornamental Box hedges. The badly infested plants drop many of their leaves and soon become very scraggy and unsightly. The conditions are such that a considerable expenditure would be justified for control work in many instances, and a series of experiments were therefore started to ascertain the possibility of destroying the Dipterous maggots within the mines, since direct control methods against the midges or methods of preventing oviposition were not specially promising. The adults fly the latter part of May and there appears to be but one generation annually.

A series of preliminary tests were made with twigs of Box kept in vials and exposed to the action of various gases in ordinary two-quart fruit jars. Under these conditions fumigation with 5, 10, 15 and 20 drops of carbon bisulfid for twenty-four hours resulted in the maggots being pronounced dead within three days without, so far as could be observed, appreciable injury to the foliage. The time was cut down to five hours, 15 drops of carbon bisulfid were used and the larvæ were apparently all killed and the foliage uninjured; 30 drops were used with an exposure of three and one-half hours with similar results.

Two teaspoonfuls of carbon bisulfid to a ten-quart bell jar were used for the fumigation of entire plants, the larvæ being killed after a two-hour exposure, while a one-hour treatment with one and one-half teaspoonfuls of the insecticide did not destroy the maggots. We are of the opinion that one teaspoonful to five quarts of space for a period of at least one hour, we prefer at present to extend the time to two hours, will kill the larvæ without injury to the plant.

Similar tests were conducted with carbon tetrachloride, and while the maggots were affected, the gas was not nearly so effectual, and after a period of twenty-four or forty-eight hours the larvæ were active and apparently normal. There was no appreciable injury to the foliage.

The most interesting tests were with C. P. ammonia. It was used

at the rate of 5, 10, 20 and 30 drops to a two-quart fruit jar, the exposure being 15 and 60 minutes. The treatment was fatal to the maggots and there was also serious injury to the foliage. The gas penetrated the mines readily and caused the collection of moisture. The latter was probably drawn from both the plant and animal tissues and resulted in an early collapse of the larvæ, especially where the larger amounts of ammonia were employed. The mines in the treated foliage had a strongly pungent ammonia odor for two to even seven days after the fumigation. It is possible that by using smaller amounts of this chemical we could secure the destruction of the larvæ without serious injury to the plants. Our preliminary experiments, however, indicate the probability of more or less damage to the foliage.

Flake napthalene used at the rate of one-half teaspoonful to a two-quart jar and giving an exposure of five hours, resulted in the larvæ becoming quiescent and eventually recovering. There was no injury to the plant. The twenty-four hour fumigation gave practically the same results.

Potassium cyanide, 95 per cent was used at the rate of one dram with one-fourth of an ounce of sulphuric acid and three-fourths of an ounce of water to 27 cubic feet, the exposure being for 15 minutes. This strength is practically one-half that recommended for fumigating nursery stock, namely, one ounce to two hundred cubic feet of space. This treatment killed some of the larvæ and did not injure the foliage.

Owing to conditions it was impossible to supplement these tests by experiments under field conditions.

Vice-President Herrick: I would like to ask Dr. Felt if he tried any contact sprays like Black Leaf 40 on the foliage.

Mr. E. P. Felt: We tried contact leaf sprays in the course of the experiments and got absolutely no results on box leaf miner. It is a thick leaf and the membrane over the mine is rather thick.

Mr. E. N. Cory: In Maryland, there was found one infestation of this insect on a hedge on a large estate. The hedge is about 600 feet long and practically two-thirds of it is infested. We have attempted some preliminary experiments with cyanide but were unsuccessful in our fumigation. We tried Black Leaf 40, one part to 500 parts of water with the addition of two pounds of fish-oil soap and were unsuccessful with that. We have planned to continue on this hedge with contact insecticides. We will also follow Dr. Felt's work and try some of his fumigation experiments on this hedge.

Mr. E. P. Felt: One more statement entirely outside of the scope of the paper. Professor Stene of Rhode Island reports fairly good

results with contact insecticides such as kerosene emulsion or whale oil soap solution, applied when the midges are beginning to emerge.

Mr. P. J. Parrott: This discussion is of great interest to me because there occurs in New York an insect which is a miner of the foliage of certain kinds of sour cherries. On the basis of the work which has been done with the elm-leaf miner, I attempted to combat the pest by the use of various contact mixtures, including nicotine preparations, soaps and oil emulsions. With none of these insecticides were we able to kill the leaf-miner. Finally we tried fumigation with hydrocyanic acid gas which was very effective. If the insect becomes a serious pest, it may be necessary to resort to this treatment, but for the present we are recommending the removal and destruction of infested leaves and cutting out of hawthorn plants in the immediate vicinity of the orchards.

Mr. W. C. O'Kane: Our experience to some extent agrees with that of Mr. Parrott. The subject is attractive only to an insecticide man who has some knowledge of the nature of the leaf. Apparently the leaf tissue in that case is of such texture that the substance will not penetrate.

President H. T. Fernald: Experiments on the box leaf miner in Massachusetts on plants brought from Newport, R. I., gave no indication that Black Leaf 40 could penetrate the tissue, and experiments with that material proved practically a complete failure. Fumigation was not considered, because of the conditions under which the box is grown, at least at Newport, where there are long hedges of it or rows of it hundreds, and perhaps in some cases even thousands, of feet continuously. It seemed almost impracticable to apply fumigation methods under such conditions of growth; but when Black Leaf 40 failed as a contact application there seemed to be nothing left to be done with the limited material available for experimental work.

Mr. E. N. Cory: Have any experiments been tried with poison sprays?

Mr. E. P. Felt: Not to my knowledge. We know almost nothing as to the effect of such sprays upon the larvæ or adults.

President H. T. Fernald: The next paper will be presented by C. P. Gillette.

NOTES ON SOME COLORADO APHIDS HAVING ALTERNATE FOOD HABITS

By C. P. Gillette and L. C. Bragg

Chermes cooleyi Gillette and its var. *coweni* Gillette

This species and its variety may be said to live all the year through, upon both the Engelmann and blue spruces for one form, and the Douglass fir for the other. The lice upon these trees now are all in first instar stage, none of them having passed through the first moult. Those upon the Engelmann and blue spruces all have their setæ thrust into the bark of the twigs where they will develop and deposit eggs in the spring, and these eggs will hatch the second generation which will produce the cone-like galls at the ends of the twigs. Early in July these galls will give out the adult winged lice of this form which will all fly to the Douglass spruce to lay their eggs upon the needles. The young from these eggs hatch, and without growing in size or moulting, will remain upon the needles with their setæ inserted along the median line until the following spring. In the spring these lice become mature and lay eggs which hatch into a brood of lice, some of which remain upon the Douglass spruce, while others go to the needles of the Engelmann and blue spruces where they deposit the eggs for the form above described that remains over winter. So each year the two forms of this species migrate, one to the Douglass and the other to the Engelmann and blue spruces. The Douglass spruce should not be planted near Engelmann and blue spruces in a yard or park.

Pemphigus betæ Doane

This insect is a native of the Rocky Mountain region, and is a rather general feeder upon the roots of plants during the summer season. The goosefoot family, especially sugar beets, garden beets and mangel wurtzels, are favorite food plants. Among our native plants and weeds, we have found this louse common upon the roots of *Aster*, goldenrod (*Solidago*), *Iva xanthifolia*, and lambsquarter, *Chenopodium*. While it does not seem necessary for this insect to take on a fall migratory habit, still, as near as we have been able to estimate, about one-half of the lice acquire wings during September and October and leave their summer hosts and fly to the cottonwoods. Apparently, only a small percentage ever find the desired host. In beet-growing sections it is common for these lice to fly in countless millions, like great swarms of ants, for more than a month during the warmer portion of the day. Since the fall of 1910 we have known that this louse migrates to the cottonwoods,[1] in large numbers in the fall to deposit

[1] See twenty-third Annual Report Colorado Experiment Station, p. 98.

the sexual males and females, but not until the past summer has it been definitely determined in what form this species appears upon the cottonwoods early in the summer. Mr. Asa C. Maxson, in charge of the experimental work in the Longmont district for the Great Western Sugar Company, who has been a collaborator with us in some plant louse studies, has succeeded the past summer in determining the form of gall produced by this louse upon the cottonwood leaves and in successfully colonizing the lice in large numbers upon the beets and in rearing from these colonies, the sexuparæ. We extract from a report by Mr. Maxson upon his work as follows: "On May 4th . . . the larvæ were located upon the upper side of the leaf which was light in color where the larvæ were feeding, and showed a depression which, as it grew larger, entirely inclosed the insect and formed a gall on the under side of the leaf. This form of gall is produced by *Pemphigus balsamiferæ* Williams."[1]

Many observations by the writers tend to confirm the conclusions reached by Mr. Maxson whom we congratulate on the excellent life history work that he has done on this insect, which is one of the worst pests that the sugar beets have to contend against in the Rocky Mountain States.

It seems probable that Parker, in Journal of Economic Entomology, 1914, page 139, hit upon the correct gall for this louse, but referred to it on page 141 as by *populicaulis* Fitch, which produces a globular gall upon the petiole of the leaf. Furthermore, this gall occurs in the Middle and Eastern States, while *P. betæ* seems to be strictly a Western species.

Pemphigus populicaulis Fitch

Winter host, *Populus* species; alternate host unknown.

Pemphigus populitransversus Riley

Winter host, *Populus* species; alternate host unknown.

Pemphigus populiramulorum Riley

Winter host, *Populus* species; alternate host unknown.

Pemphigus ulmifusus Walsh

Winter and early summer host, *Ulmus* species; alternate host unknown.

Mordwilkoja vagabunda Walsh

Winter host, *Populus* species; late summer host unknown.

Asiphum pseudobyrsa Walsh

Winter host, *Populus* species; alternate summer host unknown.

Asiphum sacculi Gillette

Winter host, *Populus tremuloides;* alternate summer host unknown.

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[1] Aphididæ of Nebraska, Williams. University Studies, Vol. X, No. 2, 1910.

Thecabius populiconduplifolius Cowen

This species has *Populus occidentalis* for its over-winter and early summer host, and migrates to native species of *Ranunculus* for the later summer and fall months. Transfers between these host plants are readily made artificially and the lice do not all leave the *Ranunculus* in the fall, so that they may be found upon *Ranunculus* the year round. In fact, many lice having alternate host plants infest one of the food plants continuously, a portion of some brood acquiring wings and migrating to a different species of plant as an alternate host.

Prociphilus corrugatans Sirrine

Occurs commonly upon *Cratægus* species as a winter host; alternate host unknown.

Prociphilus alnifoliæ Williams

Occurs upon *Amelanchier alnifolia* as the over-winter host; the alternate host unknown.

Colopha ulmicola Fitch.

Occurs upon *Ulmus americana* as the winter host, and upon *Eragrostis* species during later summer and fall. The migrants returning during September and October to the elms.

Tetraneura graminis Monell

Occurring upon *Ulmus americana* as the winter host, and upon rice cut-grass, *Lersia oryzoides,* during the summer and fall.

Schizoneura americana Riley

The sexuparæ of this species fly in great numbers to the trunks and lower limbs of the American elms during the months of September and October each year. The sexual males and females are deposited in any hiding place beneath bits of bark where it will be difficult or impossible for Coccinellids to reach them. The eggs laid by these sexual females hatch into stem-mothers the following spring that locate upon the young opening leaves and start the generations that cause the leaf-curl gall that Riley figured as the gall of *americana.* The spring migrants resemble the return migrants of the fall, and neither should be confused with the fall migrants from the apple (*lanigera*) which are bark feeders and which differ markedly from *americana* in both antennal and wing characters. So, while it seems certain that this species has an alternate food plant upon which it lives during the latter part of the summer, we have not been able to locate it.

Schizoneura rileyi Thomas

This species, also occurring on the elm, but always as a bark feeder like *lanigera* of the apple, deserves mention for the purpose of avoiding confusion with the other elm species. It is quite distinct from the other species of the genus mentioned and probably has no alternate

food plant as we have taken the sexuparæ, the true sexual forms and the eggs of this species on elm trees where colonies have been present throughout the summer.

Schizoneura cratægi Oestlund

Like *lanigera*, this is a bark feeder and occurs upon the bark of both the limbs and roots of native *Cratægus* in Colorado. It also gives off fall migrants which are much longer winged than *lanigera* and consequently more nearly like *americana* of Riley, but we do not know that its alternate host plant has been definitely determined.

Schizoneura lanigera Hausman

This species inhabits the apple throughout the year. During August and September sexuparæ migrate in large numbers from the apple, but we have never been able to find these migrants establishing themselves upon other host plants, and we have never found return migrants early in the summer coming to the apple. We are inclined to the opinion that a regular alternate summer host for this species is not positively known. We feel certain that sexuparæ from the apple do not migrate to the elm and produce either the elm leaf-curl gall, *Schizoneura americana* of Riley, or the leaf-cluster gall or rosette of the elm which was included by Riley in his species *americana*, and which we consider, for morphological and other reasons, to be a distinct species. We regret that, for Colorado at least, we cannot accept the conclusions of Dr. Patch that *Schizoneura lanigera* upon the apple has anything to do with the production of either the elm leaf-curl or the elm leaf-cluster as described by Riley. A full discussion of this matter would be too lengthy to incorporate here.

Anoecia corni Fabricius

This species winters in the egg state in large numbers upon the stems of dogwood, *Svida stolonifera*, in Colorado. The lice completely desert the dogwood early in the summer and go to unknown plants.

Rhopalosiphum rhois Monell

This louse is fairly common upon *Rhus trilobata* as a winter host in Colorado. During the summer and fall months it occurs upon many of the grasses where it seems to prefer the flower heads. We have taken it from timothy, wheat, oats, barley and native species of *Elymus*.

Amphorophora howardii Wilson

This species was described in *Canadian Entomologist* for 1911, page 59, and was referred to under this name by Davis in *Canadian Entomologist* for 1914, page 165. It seems to be a synonym of *rhois*.

Rhopalosiphum lactucæ Kaltenbach

This is a common species on *Sonchus oleraceus* during the summer

months, the stems and flower heads often being literally covered with the lice. During September and October the males and the sexuparæ desert the *Sonchus* and go to species of *Ribes*, especially *aureum* and *vulgare*, where the sexual females are deposited, and, after fertilization, deposit the over-winter eggs.

This is undoubtedly the *Rhopalosiphum ribis* Koch, which Buckton figured on Plate 39, Volume II, of his British Aphididæ along with the leaf galls of *Myzus ribis*.

Rhopalosiphum hippophæs Koch

The summer form of this louse inhabits species of *Persicaria* exclusively, so far as we have been able to determine. In the fall, the sexuparæ migrate to species of *Elæagnus*, *Shepherdia* and *Hippophæ*, which are closely allied plants, and deposit the sexual females which later deposit their eggs about the buds. The males follow when the females are about half grown.

The over-winter hosts for this species also serve as winter hosts for *Phorodon galeopsidis* Kalt., and *Myzus braggii* Gill. As a paper by the senior author of these notes, dealing with the synonomy of this group, is expected to appear soon in "Annals." We will not enter into a discussion of the matter here.

Rhopalosiphum pastinacæ Linneus

This species becomes very abundant upon *Pastinaca* and some other *Umbelliferous* plants during the summer months in Colorado, and in the fall goes to the honeysuckles belonging to the genera *Lonicera* and *Zylosteum*. Both males and sexuparæ migrate.

Rhopalosiphum capreæ Kaltenbach

This species has been much confused with *Pastinacæ* in the past because it also goes to the *Umbelliferæ* as summer hosts, and in a general way the two species are similar in appearance. Under the microscope, however, *capreæ* is easily distinguished by its caudal horn appearing like a second tail, and its winter host is always a species of willow. For a fuller discussion of these species see JOURNAL OF ECONOMIC ENTOMOLOGY for 1911, page 320. These species could well be placed in different genera.

Hyalopterus arundinis Fabricius

Occurs abundantly upon plum and prune as over-winter hosts, and migrates in early summer to Reed Grass, *Phragmites communis*, from which the males and sexuparæ return to *Prunus* in the fall.

Aphis bakeri Cowen

This species winters freely upon both the cultivated apple and *Cratægus*. It migrates early in the summer to the white and red clovers.

When the plants are large or somewhat protected we have found this species spending the winter upon the leaves of red clover. While this is a common louse in Colorado, and we have done a large amount of collecting for plant lice, we have never found it established upon any herbaceous plant outside the clovers.

Aphis setariæ Thomas

A rather common species infesting the plum as a winter host in Colorado, and going to the grasses for the summer. We have taken it most commonly during the summer upon *Panicum crusgalli*, but also upon *Setaria* sp.

Aphis viburnicola Gillette

The sexuparæ of this species come very regularly in large numbers to the snowball, *Viburnum opulus*, every fall. Soon after the creamy white sexual females have begun to develop, the males follow and later the eggs are deposited about the buds and axils of small twigs. The young of the stem-mothers all get wings and leave the snowball bushes, but we have never been able to locate the alternate host where the summer months are spent.

Aphis avenæ Fabricius

We have, at least, two or three species of *Aphis* which occur upon both the apple and some of the grains and grasses that belong to what we have designated as the *avenæ* group. At present, we prefer to pass this group by as we are not able to satisfy ourselves as to just which of these species *avenæ* really is.

Myzus bragii Gillette

This species spends the winter upon *Elæagnus* and migrates to the Canada thistle, *Carduus arvensis*, as the summer host. It seems probable that there are additional summer hosts, but we have not been able to locate them.

Myzus persicæ Sulzer

This species passes the winter upon pit fruits, peach, plum and cherry with an apparent preference for the peach. The spring migrants go to a very wide range of summer hosts, some of the most important of which are the cabbage and other cruciferous plants, potatoes, tomatoes, beets, species of *Rumex, Dianthus*, etc. This louse is another species that is able to continue its existence from one year to another in protected places out of doors and in greenhouses.

Phorodon humuli Schrank

Winters on the plum, and in Colorado we have taken it in some numbers upon plum foliage throughout the year. The regular summer host is the hop.

Macrosiphum granaria Kirby

The eggs of this species are deposited upon rosebushes in the fall. Early in the summer the migrants go to oats and wheat, and probably to some other grains and grasses.

Macrosiphum dirhodum Walker

This species, like the preceding, has the rose as a winter host, and goes to the grains and grasses during the summer.

It seems a surprising thing that, after so much study of the life habits of the Aphididæ, there are still so many species having the habit of alternating their annual host plants, where only one of the winter hosts is known. There is still abundant opportunity for much good research work along this line.

President H. T. Fernald: We will now take up a paper, the title of which failed to be printed on the program, by Mr. E. B. Blakeslee.

A MECHANICAL PROTECTOR FOR PREVENTING INJURY BY THE PEACH BORER

By E. B. Blakeslee, *Washington, D. C.*

(*Abstract*)

This paper briefly discussed the feeding habits and behavior of newly hatched peach borer larvæ. The point was emphasized that, in addition to the fact that large numbers of eggs are deposited about the crown of the tree, larvæ hatching from eggs deposited on trunk and branches instinctively migrate downward and begin their work below the surface of the soil. When an impenetrable barrier was placed at the crown of the tree, the larvæ made no attempt to enter above it. By the use of a cone-shaped tarred paper protector, extending out for eight inches to one foot from the base of the tree, and sealed with a viscous substance, it was found possible to entirely exclude the larvæ from the tree. The protectors were cut out in circular form with a hole in the center somewhat larger than the trunks to which they were to be applied. To serve as a support for the protector the earth was pulled up to the tree, slightly, making a small mound, the base of which was slightly below and the top slightly above the surface of the ground. The protectors were then brought tightly about the tree and fastened, the contact with the tree and the laps coated with a sticky sealing material and the earth pulled back over the edges. Field experiments showed that these protectors were able to maintain

their impenetrable character under field conditions. Photographs of the protector were exhibited.

Mr. E. B. Blakeslee: Mr. Scott has secured very good results with a device which is essentially the same as the one described.

A Member: I would like to inquire if in these experiments anything like cement was used which would harden in the soil?

Mr. E. B. Blakeslee: We have not used cement or gas-tar mixtures for fear of injuring the trees. I do not think the cement would give good results.

A Member: Some years ago we tried a series of experiments to test mechanical protectors of various sorts as a remedy for the peach borer. Those that we tried usually caused considerable injury to the trees.

Mr. E. G. Titus: In Utah, we find that peach borers attack the trunks and branches as well as the crown of the tree. This makes it difficult to use a mechanical protector.

Mr. Wilmon Newell: To me this is a very interesting paper. I think a glance at these photographs will convince any entomologist that the right principle is being correctly applied. We were working on this same insect in Texas a couple of years ago and tried to make application of the same principle. We even went so far as to make paper protectors but were not successful in sealing them to the trunks of the trees.

I am familiar with the work done along this line by Mr. Scott the past summer, and mentioned by Mr. Blakeslee. I happen to know that Mr. Scott's protectors, very similar to these but made in a different way, were placed on the trees early in the season. The results were such as to convince me that a method of control for one of our worst fruit tree pests has been developed. We should not let this matter pass without getting all the information we can and I would like to ask if Mr. Scott will give us the results of his work along this line.

Mr. W. M. Scott: I was not aware that this subject would come up for discussion and therefore did not come prepared with notes on the results of my experiments, except such as I happen to have in this little pocket note-book.

I began experiments for the control of the peach tree borer while State Entomologist of Georgia, about 15 years ago, and have since continued to work on this problem as a peach grower. After trying numerous washes I concluded, as did Mr. Blakeslee, that this was not the right method of procedure. The habit of the newly hatched larvæ to crawl down the trunk of the tree and enter the moist tender bark below the surface of the soil furnished the clue to the solution of the

problem. In order to prevent injury from this insect, it is necessary to prevent the larvæ from reaching the underground portion of the tree. This is easily accomplished by encircling the trunk at the ground with a flexible soil-covering mat which must be impenetrable to borers and impenetrably sealed to the tree.

Last March I began to devise a protector that would fulfill the requirements and finally adopted a tarred felt mat, 16 inches in diameter, with a hole in the center to conform to the diameter of the tree and a slit from the hole to the outer edge. The soil is first mounded somewhat around the tree and the protector placed over this mound. The slit edges are lapped and glued together with a viscous material and the protector is sealed to the tree with the same material, completely filling all openings, so that it is impossible for the borers to reach the soil without crawling away from the tree beyond the outer edge of the protector. The viscous material for effecting an absolute sealing to the tree is an essential feature of the protector. I tried several substances and found the best to be a sticky preparation consisting, for the most part, of a residuum from the partial distillation of coal tar.

Beginning on June 9, 1914, I applied protectors to 250 peach trees in my orchard at Hancock, Md., and the results were perfect except where the mat was not properly sealed to the tree. An examination on October 2 showed that of 40 Belle trees provided with protectors, 28 were entirely free from borers, 7 had one each, 4 had two each and 1 had sixteen. The protectors had broken loose from the trees where a poor paste was used and this accounts for the successful entrance of the borers in these trees. It also emphasizes the necessity of maintaining an absolute seal between the protector and the tree. An average of 12 borers per tree was found in 15 unprotected trees nearby.

In a block of three-year-old Elbertas 20 treated trees were examined and 16 of them found free from larvæ. The protectors had partly cracked loose from the other four trees, admitting from 1 to 5 borers. Twenty untreated trees in an adjacent row were examined and found to be nearly ruined by borers. There was an average of 28 borers per tree and 5 trees averaged over 40 per tree. This gave the protectors about as severe a test as they could be subjected to.

Now in justice to myself and others I should admit that, on September 30, I applied for a patent on this method of protecting trees against borers.

Mr. T. J. Headlee: Mr. Blakeslee, what did you use for sealing the protector?

Mr. E. B. Blakeslee: I used "tanglefoot," it was the best thing I could find. I find the tanglefoot seems to retain efficiency under ordinary conditions. It doesn't dry out.

Mr. T. J. Headlee: We have used tanglefoot for two seasons and while there was no injury the first season, during the second season the bark has died beneath the tanglefoot and the trees have perished. Our applications were made on a very small surface of the tree.

Mr. A. L. Quaintance: I want to congratulate both Mr. Scott and Mr. Blakeslee for this discovery—independent discovery, as I happen to know. It appears to be a true case of parallel development. I am inclined to believe that the development of this tree protector marks the finish of a first-class insect pest which, up until now, has never been satisfactorily controlled. Of the many species of pernicious insects with which the orchardist has to contend, none have been more troublesome for a longer time than the peach borer. It is noted that Mr. Scott has applied for a patent for this protector. Should this be granted to him, the bureau will naturally discontinue further work along this line. It may contribute to its more speedy adoption by peach growers that it should be pushed by private interests, and I feel perfectly sure that no claims will be made by Mr. Scott as to its merits which, in his judgment, are not fully warranted. I certainly hope that it will be used by peach growers everywhere who are troubled with the peach borer.

Mr. W. E. Rumsey: In our experiments at the West Virginia Agricultural Experiment Station against the peach tree borer we have been trying some penetrating substances which were sprayed on the base of the trees to determine if it is practical to destroy the young borers in this way. While the work has not been under way for a sufficient length of time to obtain definite results some interesting observations have been made. Two of the materials used for the purpose mentioned were avenarius carbolineum emulsion and "Orchard Brand" miscible oil (1–9). To apply the materials the soil was removed from the base of the tree, as is done in "worming," and the trunk sprayed from six or eight inches above the general surface of the ground to the bottom of the cavity made by the removal of the soil. After spraying the dirt was replaced. The materials were applied in October and the trees examined the following June. The check trees showed an average of about five borers to a tree; with the miscible oil treated trees the average was one borer per tree; and where carbolineum emulsion was used we found an average of less than one borer per tree.

When applying the carbolineum emulsion night came on before the work was completed and when we returned the next morning three dead borers were found on the bark of the last tree treated the previous evening. One had worked its way completely out of its burrow and the other two were half way out. This indicates that the emulsion

had penetrated the bark and the borers had tried to escape. In the use of the two substances mentioned there was no apparent injury to the trees.

SECRETARY A. F. BURGESS: I would like to ask Dr. Headlee if both old and young peach trees were injured by tanglefoot? We are using large quantities of this material each year and seldom notice any injury, although we very rarely apply this material to peach trees.

MR. T. J. HEADLEE: The tanglefoot was applied both to young trees with thin tender bark and to old trees with rough heavy bark in bands about eight inches wide, beginning two or three inches below the surface of the soil and extending five or six inches above. The young trees first exhibited injury, but sooner or later practically all succumbed.

PRESIDENT H. T. FERNALD: If there is no further discussion, we will take up a paper by George A. Dean and R. K. Nabours.

A NEW AIR CONDITIONING APPARATUS

By GEO. A. DEAN, *Entomologist*, and R. K. NABOURS, *Zoölogist, Kansas Agricultural College and Experiment Station*

Within the last ten years the influence of moisture and temperature on animal life has received considerable attention. It is not necessary to emphasize the value and the absolute necessity of accumulating data relative to this important phase of entomological and zoölogical work. The difficulty in this work has been to devise or to secure some sort of an air conditioning apparatus that would maintain a desired constant humidity and temperature within a reasonable degree of variation. Different individuals have devised various machines and incubators for this purpose, but to the knowledge of the writers they have all proved more or less unsatisfactory. For several years the departments of entomology and zoölogy of the Kansas Experiment Station have been building and experimenting with various moisture and temperature control apparatus. Last spring at the suggestion of Professor Potter, of the Engineering Division, it was decided to take the matter up with some air conditioning specialists. After conferring with several companies a contract was made with the Carrier Air Conditioning Company, of Buffalo, N. Y. The plan was to construct and install a machine that would automatically condition the air before it entered the breeding chamber, flow it into the breeding chamber continuously and at a rate that would make a complete displacement of the air at least every minute.

Just recently the air conditioning machine has been installed and

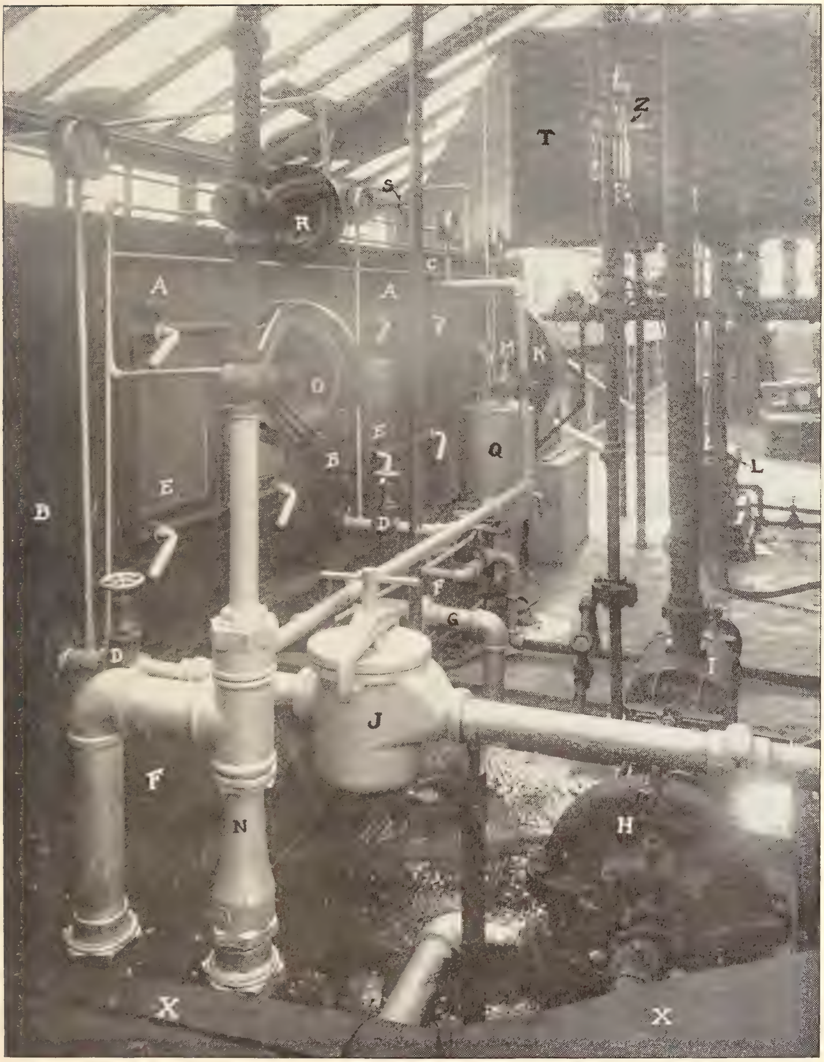
it is the object of the writers at this time to present the general arrangement of the apparatus, the principle of operation, and the moisture and temperature records maintained in the breeding chamber.

The spray chamber shown at A (Plate 1) is nine feet long and is provided with nozzle standpipes B, arranged in two groups or banks, placed about three feet apart, with the last bank three feet from the eliminator plates. The flooding of the eliminators is done by an independent set of nozzles shown at C across the top. These nozzles distribute the water over the washing surface uniformly. Valves shown at D outside of the spray chamber are provided on each bank of nozzles and also on the flooding nozzles over the washing surface, and thus either or both banks of nozzles can be closed to regulate the humidity. With both banks of nozzles closed, no appreciable increase in humidity of the air is produced. With one bank in operation (and the water recirculated without being heated) the humidity of the air will be increased about sixty per cent. With both banks of nozzles in operation, the humidity is increased about eighty per cent. If the water is heated the air leaves saturated. The banks of sprays can be opened or closed and the temperature of the water also varied as required.

Two water-tight inspection doors shown at E (Plate 1) are provided to allow easy access to the spray chamber. Beneath the entire washer and eliminator is a settling tank F, sixteen inches in height. A strong frame, built of angle iron, encloses the settling tank, to which it is firmly united, making a very rigid and substantial base to support the balance of the washer. The tank is provided with an automatic float valve, which controls the water supply and maintains a constant water level in the tank; an overflow valve G, which connects to the sewer and which prevents flooding the tank; a drain valve arranged under the bottom of the tank and which connects to the sewer, so all the water may be drawn off for cleaning.

The settling tank is divided into two compartments by a wire cloth strainer, through which the water passes before entering the suction of the pump H.

Connected to the passage just beyond the eliminator chamber is the air suction fan shown at K (Plate 1) propelled by a steam turbine L. This fan draws the air through the spray chamber of the air washer and humidifier, where it comes in contact with the atomized spray of water. The evaporation of a portion of the spray water humidifies the air and the amount thus evaporated depends upon the relative temperature of the water. Leaving the spray chamber, the air next passes over the washing surfaces of the eliminators and then over the stem of a graduated thermostat shown at M (Plate 1) placed in the passage just beyond the eliminators, so that it is exposed to the tem-



THE HUMIDIFIER AND AUTOMATIC CONTROLLING MACHINERY

A, spray chamber; *B*, nozzle standpipe; *C*, nozzle standpipe over the eliminators; *D*, valve for nozzle standpipe; *E*, water-tight inspection door; *F*, settling tank; *G*, overflow pipe; *H*, double suction centrifugal pump; *I*, spiro steam turbine with direct connected suction pump; *J*, pot strainer; *K*, suction fan; *L*, spiro steam turbine; *M*, graduated thermostat; *N*, ejector water heater; *O*, direct acting diaphragm valve; *Q*, compressed air storage tank; *R*, reverse acting diaphragm valve; *S*, safety relay; *T*, tempering or heating chamber; *X*, air duct leading from breeding chamber to spraying chamber; *Z*, automatic lubricator.

perature of the air leaving the washer, and its expansion or contraction is caused entirely by this temperature, and the variation due to its expansion is made to regulate this temperature. The water heater of the ejector type shown at N is placed in the suction line to the pump. The heater operates like a barometric condenser, so that the temperature of the spray water is varied by varying the amount of steam furnished to the ejector.

The diaphragm steam valve shown at O (Plate 1) is placed in the steam line which supplies the water heater. The valve is operated by compressed air from the graduated thermostat.

The air compressor shown at P (Plate 2) furnishes compressed air to the storage tank Q (Plate 1) at about fifteen pounds pressure. The compressor is driven by the same steam turbine L, that drives the air suction fan K.

The reverse acting diaphragm valve shown at R (Plate 1) is normally closed, but is opened by compressed air from the tank, passing through the safety valve S.

This method of control is extremely sensitive, as any variation in the air temperature passing over the stem of the graduated thermostat produces a change in the air pressure on the diaphragm steam valve, causing the valve to partially open or close, thereby producing a new water temperature. In only a few seconds this water is sprayed into the air, affecting its temperature, giving to it more or less heat in accordance with the requirements of the thermostat. This air in about one second passes over the thermostat stem, imparting to it the change in temperature.

The air then passes to the tempering or heating chamber T (Plate 1) to be heated sufficiently to maintain the required temperature and moisture. The heating chamber consists of six double-section steam radiators of the vento type, each having a radiating surface of sixteen square feet. The radiators are so constructed and so arranged as to distribute and heat the air uniformly before it flows into the breeding chamber. One or more or all six of the radiators may be used in accordance with the requirements of the air. The steam entering the radiators is automatically controlled by the graduated thermostat shown at U (Plate 2), placed in the breeding chamber. The entering air is evenly distributed in the chamber and flows over the stem of the thermostat. The expansion or contraction of the thermostat is caused entirely by this temperature and the variation due to its expansion is made to regulate this temperature. The diaphragm steam valve shown at V (Plate 2) placed in the steam line W that supplies the steam for the radiators, is operated by compressed air from the graduated thermostat in the breeding chamber. The thermostat produces

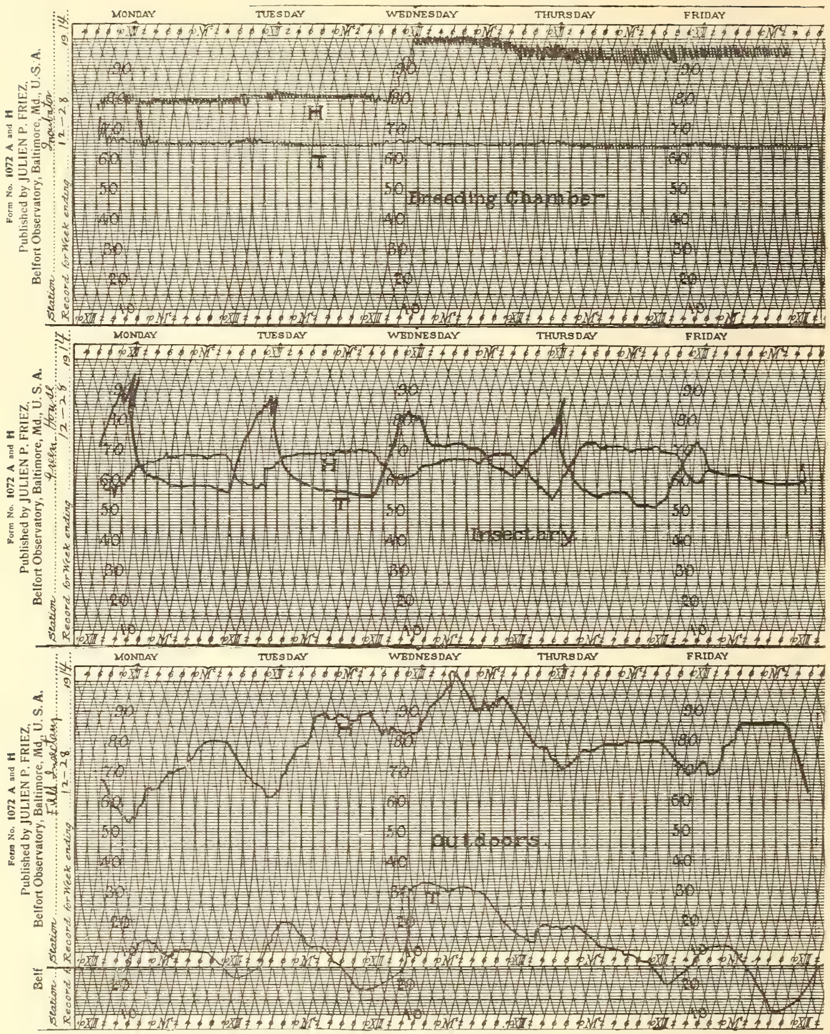


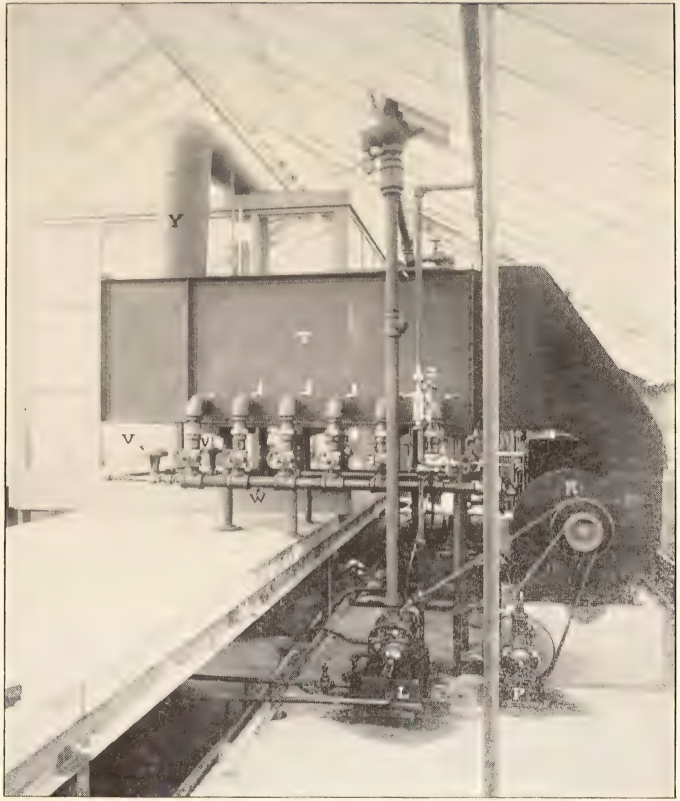
FIG. 8.—Charts showing the moisture and temperature control in the breeding chamber from December 21 to 9.00 o'clock December 26, 1914, compared with the humidity and temperature in the insectary and outdoors. *T*, temperature; *H*, humidity.

NOTE.—The temperature during the night of December 25 was ten degrees below zero. This air was brought directly into the spray chamber and in less than three seconds was passed into the breeding chamber at a temperature indicated by the chart.

LETTERING FOR PLATE 2.

K, suction fan; *L*, spiro steam turbine; *P*, air compressor; *T*, tempering or heating chamber; *U*, graduated thermostat; *V*, diaphragm steam valve; *W*, steam line; Y, air duct leading from heating chamber to the breeding chamber; *Z*, automatic lubricator.

Breeding Chamber



Heating Chamber and Controlling Machinery
See opposite page for explanation of lettering.

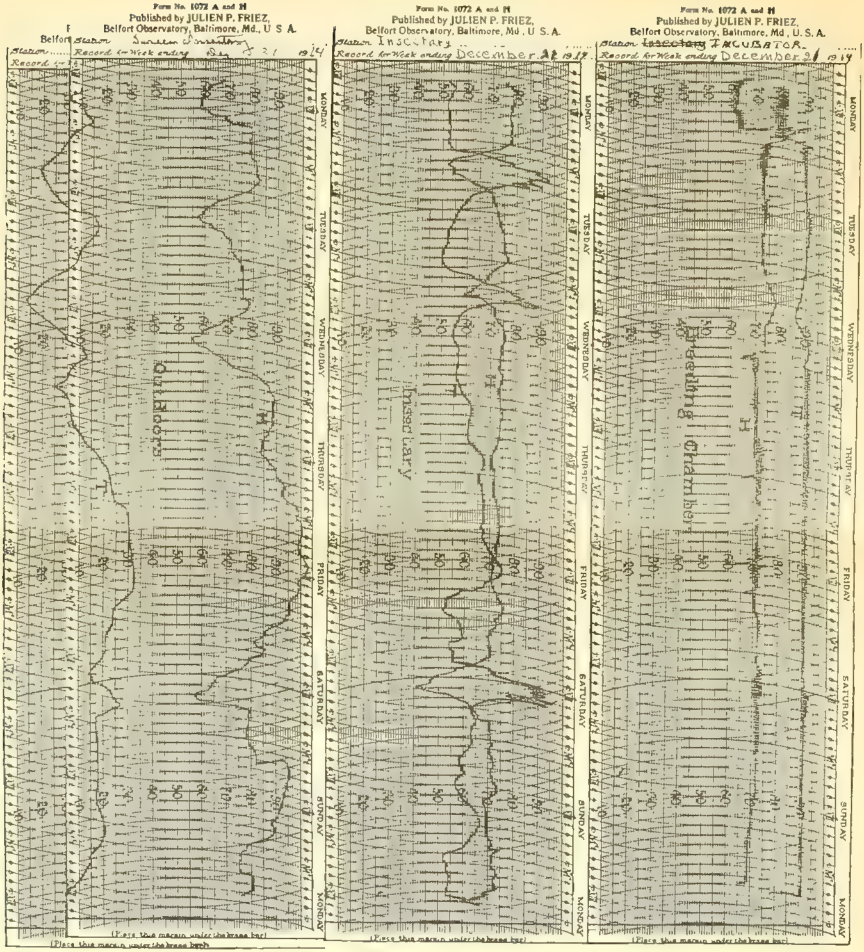


FIG. 7. Charts showing the moisture and temperature control in the breeding chamber from December 14 to December 21, 1914, compared with the humidity and temperature in the insectary and outdoors. *T*, temperature; *H*, humidity.

NOTE.—Part of the time the cold air from outdoors was brought directly into the spray chamber

a change in the air pressure on the diaphragm steam valve, causing the valve to partially open or close, thereby controlling the temperature of the heating chamber.

The breeding chamber (Plate 2) consists of a double glass-walled room, six feet wide, eight feet long, and seven feet high, with a small entering vestibule. A complete change or displacement of the air in the breeding chamber is produced every minute, the air flowing out at the bottom of the chamber and entering the spraying chamber by means of a large air duct shown at X. The outside air may also be brought in by means of a large air duct which comes in from the outside and enters the same chamber as the air duct coming from the breeding chamber.

We gratefully acknowledge complete support for this undertaking from Director W. M. Jardine. We are under special obligations to Mr. A. W. Bellomy, assistant in genetics, for much of the work and the whole of the supervision of the installment of the apparatus. We also desire to express our appreciation of the invaluable services of Prof. A. A. Potter and members of his staff in the Engineering Division and of Mr. A. E. Stacey, of Chicago, engineer for the Company.

Mr. T. J. Headlee: Thinking that the members of this Association might be interested in a less expensive apparatus intended to control temperature and moisture, I will venture to describe one which I have recently devised. It consists of two small heating chambers under absolute control. The Freas Electric Incubators will serve well or a cheaper form can be made. Within each of the two chambers is placed an air-tight glass receptacle. By means of properly insulated tubes the two air-tight chambers are connected. By means of a faucet pump air from outside the building is sucked through the two chambers. In passing through the first incubator the air is heated to a given temperature and saturated with moisture by passing it through a series of waterfilled chambers. On entering the second chamber the air is heated to the temperature desired for the insect and given the proper degree of relative humidity. By raising or lowering the temperature of saturation, within reasonable limits, any relative humidity can be created and maintained. In course of rigid tests recently completed, two degrees of humidity were maintained for one week each. In an apparatus such as this the size did not permit the use of a thermo-hygrograph and it was necessary to resort to a modified form of the dew-point apparatus. If care be used in purchasing the chambers, it is possible to secure chambers at \$100 to \$125 a pair. No doubt further mechanical improvement

would lower the cost. With six pairs, costing from $600 to $750, six different temperatures could be maintained simultaneously and the response of an insect to temperature under specified moisture conditions determined in a short time. Furthermore, by the exclusion of light or the use of artificial light of known composition and known intensity, the disturbing influence of variable light could be eliminated.

The machine just outlined by Mr. Dean seems really to serve a different purpose and not to be capable, except as its units are multiplied or modified, of lending itself to the study of insect response to temperature and moisture. I say this because the number of chambers is so small that any close determination of response with it must involve the running of the temperature and moisture ranges of a single insect in several successive experiments, two degrees of temperature or moisture being studied at a time, thus introducing another complex variable. This apparatus does, however, provide a means of studying insect life-history under known conditions of temperature and moisture. It is also possible by use of smaller chambers within the larger ones to run simultaneously a sufficiently large number of temperature or moisture-response experiments to derive reliable data on which to base laws of response.

Mr. G. A. Dean: In the discussion of the air-conditioning apparatus I neglected to state the cost of installing the machine. The total cost of the apparatus, including the breeding chamber and installation, is from $1,600 to $1,800. This is not an expensive apparatus when you think of controlling the moisture and temperature in two large chambers each 6 x 8 x 7 feet, or chambers large enough for a man to enter and carry on his experiments. The machine, as the illustrations show, is built for durability and should last for many years.

Mr. F. C. Bishop: I should like to ask Mr. Dean about the degrees of humidity. You say you have it at 60 degrees, but could you maintain it lower?

Mr. G. A. Dean: The most difficult control would be a low humidity with a low temperature. There would be no difficulty in maintaining either a low humidity or a high humidity with a high temperature or a high humidity with a low temperature. If you want a low humidity with a low temperature, one bank of spray nozzles should be turned off so that the relative humidity of the air passing through the spray chamber will be about 60 per cent. The temperature of the air will be within one degree of the temperature of the spray water. When this air is passed to the heating chamber and the temperature raised, the humidity will be lowered. If the temperature and humidity are not low enough the air will have to pass through colder water; for instance, one could use salty ice water. This water

can be used in the spray chamber as well as hydrant water. Bear in mind if you know the absolute humidity and temperature of the air as it leaves the humidifier or spray chamber, the thermostat in the breeding chamber can be set so as to lower the humidity of the air as it passes through the heating chamber. Of course, this increases the temperature of the air.

Mr. W. C. O'Kane: I would like to ask Mr. Dean how in summer, when the atmosphere is saturated, he is going to maintain a low humidity in his machine.

Mr. G. A. Dean: Pass the air through cold water which will give it a temperature within one degree of the water and then condition the air in the heating chamber, by setting the thermostat in the breeding chamber so as to heat or expand the air which will reduce the humidity. If hydrant water is used I don't suppose the temperature would be much below 60 degrees. There would be no difficulty whatever in maintaining a low humidity with a high temperature.

Mr. W. C. O'Kane: With a low temperature and low humidity.

Mr. G. A. Dean: You cannot get a temperature in summer lower than the water used in the spray chamber. If a temperature lower than the hydrant water is desired you must use ice water or even salty ice water. This will give you a low temperature, say perhaps thirty degrees. Then if this air is heated, say to sixty or seventy degrees in the heating chamber, it will be expanded and, of course, the humidity will be lowered. It should be remembered that the apparatus is so constructed as to use the air from the breeding chamber, which will enter the spray chamber already partly conditioned.

President H. T. Fernald: We will now listen to a paper by Dr. Howard.

NOTES ON THE PROGRESS OF ECONOMIC ENTOMOLOGY

By L. O. Howard

When General W. G. LeDuc took office as United States Commissioner of Agriculture July 1, 1877, just 37 years ago, the annual appropriation to the Department was $174,086.96, and there were 77 employees. The Department was in the main a statistical, correspondence and seed distribution bureau. Virtually no research was being carried on. The entomologist, with one assistant only, was engaged almost entirely in the general museum work of the Department. In the country at large there were no state experiment stations, and but three state entomologists, Riley in Missouri, Thomas in Illinois, and Fitch in New York, the last past his days of work. There were prac-

tically no teachers of entomology. Hagen had a few students at Harvard, but did not touch on the economic aspects of the science; Comstock was just beginning to teach at Cornell; Burrill was giving a few lectures out west, and Fernald was soon to begin at Orono.

When Doctor Houston took office as Secretary of Agriculture July 1, 1913, the annual appropriation to the Department was practically eighteen millions of dollars ($17,986,945) and there were 14,478 employees. The Department had become the greatest research organization in the world. The appropriations for entomology were $742,210. The entomological service had become a large Bureau with about six hundred employees of whom more than two hundred were scientifically trained experts. Every state had its competent agricultural experiment station with a force of entomologists. Practically every state had also its agricultural college with teaching in general and economic entomology. In California there were even County Entomologists, and Boston and Philadelphia had their City Entomologists.

In a way the wonderful general increase in agricultural research and agricultural endeavor had carried economic entomology along with it. The passage of the Hatch act and the consequent founding of the state experiment stations were responsible at once for a great increase in the number of working entomologists, while in immediate succession the introduction of the gipsy moth into New England, the appearance of the San José scale in the east, the march of the cotton boll weevil into the southern states, and the discovery of the carriage of disease to man and animals by insects, have made the importance of entomological work greater and greater. It is no wonder that the country rose to these emergencies; that Congress and the legislatures have given large appropriations, and that by virtue of the successful investigations of our rapidly increasing group of entomological workers, the United States has already gained a commanding position among the nations of the world in this branch of applied science.

It is not generally realized, except among a limited group of teachers, just how this extraordinary advance in a few years has influenced the number of students seeking information on economic entomology at the different institutions, nor just in what way it has influenced the character of the instruction. The present year in six of the leading agricultural colleges where most attention is paid to economic entomology, there are 1531 students in entomology and 51 teachers of entomology. These institutions are the Ohio State University, the University of California, Cornell University, the Massachusetts Agricultural College, the University of Illinois and the University of Nebraska. These six I have chosen because they have the largest number of students in this line, but in every agricultural college in the

country sound teaching is going on. In the south, at Clemson College, S. C., at Auburn, Ala., at Baton Rouge, La., and at College Station, Texas, and elsewhere, there are numbers of students and excellent courses. In the northwest it is the same. At Wisconsin there are 103 students and five teachers. In the small college at Bozeman, Montana, there are 27 students. The men in charge of these different departments are all practical men. Most of them, in fact I think all of them, are primarily economic workers. Many of them have been and are still connected with the state agricultural experiment stations. Some of them have been connected with the force of the Bureau of Entomology of the United States Department of Agriculture. Several of them are still collaborators of the Bureau. It follows that these men know the economic problems which confront us, and that they have a broad knowledge of what is going on, not only in this country but in other countries; and it follows further that the instruction which they give is that best designed to bring practical results. Moreover they are a harmonious and coöperative body of men. They all belong to the Association of Economic Entomologists, which, through its annual meetings and its standing committees is constantly facilitating such coöperation. All of these men are keen to grasp new ideas and are so non-conservative as to methods of teaching that they will at any moment introduce new features and new methods.

In its international aspects, economic entomology is developing with great rapidity and will continue to do so. The Association of Economic Entomologists early elected to its membership practically all of the official entomologists of foreign countries, which brought about a universal exchange of publications and frequent correspondence. This has led to visits to America by many foreign entomologists, and many of our own men have gone abroad, so that personal relationship has brought about friendships and mutual aid. There are constant visits to this country on the part of younger men from other countries, for study in the different lines of economic entomology, and the Imperial Bureau of Entomology of Great Britain has, with Dr. Andrew Carnegie's financial aid, founded a series of scholarships in economic entomology which brings several specially selected young Englishmen to this country each year to study in the Bureau and at the colleges and experiment stations. There are six of them in the United States at the present time. They all want to go back to take part in the war, but their government will not let them do so. All this will bring about in the near future an increase in the solidarity of interests and information and mutual helpfulness which already exists among the economic entomologists of the whole civilized world. Each new idea is and will be almost instantly known to all and speedily tested in

every climate and under all sorts of world conditions. Important parasites found in a remote region will not have to be carried immense distances in the future, but will be relayed from one country to another, a generation or so reared at each stop and then sent on.

The passage of the Federal Horticultural Law in 1912 has brought us into the closest relationship with the plant inspection services of other countries, and last year at a congress in Rome an effort was made to harmonize laws and to bring about comparatively uniform systems by the different countries. This is a movement which will gain force in the future. One of the more trivial and unconsidered aspects of the present war is its effect on inspection services. Of course shipments of plants and plant products from the countries engaged are almost entirely at a standstill, but arrangements have been made by our authorities to accept Holland's certificates for Belgian shipments, and the other day I received a note from the French Ambassador stating that his government had cabled him on behalf of Dr. Paul Marchal to the effect that the French inspection service will be carried on to the best of his ability under the circumstances.

How the entomological problems of the future will be met can only be guessed at, but the work of the past few years has greatly increased our belief in the necessity for the most thorough biological study of every injurious form. So many instances have occurred with species whose life history was apparently well understood and whose behavior was also thought to be known but which have been found under intensive study to possess unexpected points of attack, that the importance of the closest study of every species from every point of view has become very evident. The trend is towards intensive study of every phase of the insect's existence.

Since we have built up in this country in these past twenty or thirty years such a very respectable branch of knowledge which we have termed "economic entomology" or "applied entomology," we are naturally proud of our accomplishment and anxious to see the good work continue in the same general way and *under the same name*. But there is a tendency now to break into the solidarity of our branch of science and to unite us with the plant-disease people under the term "phytopathology" in so far as insects affect plant life, and with the internal parasite people, under the term "parasitology," where insects directly affect man or animals. I think that economic entomologists should resist this tendency. The term "phytopathology," in this significance, apparently originated in Germany. Perhaps for the reason that at the time there were practically no economic entomologists in Germany, there was no protest, but when the European San José scale scare occurred in 1898 and an inspection service was started in that

country to prevent the incoming of this dreaded insect, a plant disease man was put at the head of the service, a curious anomaly which probably might not have occurred elsewhere. It is true that an entomologist was appointed under this person, but the service suffered. The term "phytopathology" should be restricted to plant diseases, and many Germans themselves believe this. A society of economic entomologists, on the plan of our own association, was founded in Germany last year, and, through its efforts and increasing importance, it is likely that the encroaching botanists will be held in check. It is perhaps of sufficient interest to state that the congress which was called at Rome last year to consider inspection services was called a phytopathological congress although it was distinctly understood that the function of the congress was to consider questions relating principally to the prevention of international transportation of injurious insects. The United States sent no delegate to this convention, but did send a letter urging that future congresses of the same nature should be termed congresses of economic entomology and phytopathology.

It is very obvious that plant pathology and economic entomology are unrelated in their basic principles. Their successful study requires from workers absolutely different training and wholly different technique. To combine them into one service would be impracticable, except as units of a large agricultural institution. To combine them under one name as a branch of agricultural science is absurd!

The second term, "parasitology," has perhaps a better justification than the other, but the questions relating to the damage done by insects to man and domestic animals is competently handled by the economic entomologists familiar with the whole range of entomological activity. Why take a protozoölogist or a helminthologist and make him learn all about the insects that affect animals in order to become a parasitologist, when the men who have always worked at economic entomology are handling the same questions under another term? In our entomological proceedings and in our entomological journals and our entomological reports all matters relating to insects are brought together. Why put entomological material together with a lot of plant disease material into a publication entitled phytopathology, and why mix up a lot of entomological material with a lot of other material on worms and the like in a publication called parasitology? And after a branch of applied science has been so well grounded and so successfully carried on under a comprehensive and at the same time exact term like "economic entomology," why try to confuse matters and break into a field so well defined and so successfully organized?

Both terms have come to us from Europe, and the attempt to in-

troduce them into this country has been made by Americans who have studied under European masters. It seems to me, however, that the term "economic entomology," or "applied entomology," is more likely to take a firmer hold in Europe than is the term "phytopathology," in this significance, to gain ground in this country, and that will mean that internationally the term "economic entomology" as applying to the whole field will be generally adopted.

That side of economic entomology which relates to the carriage of disease by insects has been aptly termed "medical entomology," and is best carried on by trained entomologists. The truth of this statement is probably self-evident, but if a convincing argument is needed, it will be found in Hunter's admirable address on medical entomology before the Twenty-fifth Annual Meeting of the Association of Economic Entomologists (JOURNAL OF ECONOMIC ENTOMOLOGY, February, 1913, pages 27 to 38). It is in this field of applied entomology that we must perhaps look for the greatest advances in coming years.

And now at the close of 1914, after considering the results already achieved, and with a knowledge of the investigations under way and of the men who are handling them, with the sound instruction which is being given in two score institutions of learning, with the hundreds upon hundreds of clever students, many of whom will make this field their life work, it is impossible to avoid the conclusion that we are carrying on and will continue to carry on a winning fight against the greatest enemies of the human race.

MR. C. GORDON HEWITT: I would like to express my great appreciation and full concurrence with all that Dr. Howard has said in this most admirable brief résumé of the present position of economic entomology. I want to say for my own part that I am entirely in sympathy with the remarks of Dr. Howard in the latter part of his address where he spoke of merging economic entomology and plant pathology under one head. Dr. Howard has pointed out that the misuse of the term originated in Europe. For many years there were not in Europe economic entomologists of the same training and standard as we have here and often the plant pathologist and economic entomologist were one and the same person and the work was included under the same head, particularly on the European continent. I am very glad, indeed, that Dr. Howard has pointed out the importance of keeping entomological work separate, because I think we ought to take a firm stand at this time when there is still a tendency in certain quarters to include entomology under the term phytopathology. While we all realize that our work is very intimately associated with plant

pathology, just as it is also with bacteriology, it is nevertheless necessary to keep it absolutely distinct.

Before sitting down, I should like to publicly express my hearty thanks to Dr. Howard and to the members of the Bureau and also to entomologists in the United States—for their hearty coöperation with us in our work in Canada. I realize more than anyone else the necessity of our work being international in scope and character. The international boundary is not recognized by our governments in a military manner and as insects do not recognize such political frontiers, we shall succeed best in our efforts by the closest coöperation over the whole range covered by the insects we may be endeavoring to control.

Mr. E. P. Felt: It is unnecessary to discuss Dr. Howard's paper, because he has given us a most admirable summary; but I think, speaking for myself and probably for other members of the Association, that we all heartily indorse Dr. Howard's position.

President H. T. Fernald: I have been very much interested in Dr. Howard's remarks and heartily agree with him on every point which he has made—in fact, the paper was so conclusive that I questioned in my own mind if there would be the possibility of much discussion on lines where we were all certainly so much in hearty agreement with the positions he took.

Report of the Section of Apiary Inspection

The third annual meeting of the Section of Apiary Inspection was held in Philadelphia, Monday evening, December 28, 1914. Inspectors were present from ten different states. Reports of progress being made in apiary inspection work were given by all inspectors present. It was reported that efforts are now being made by several states to have a new apiary inspection law passed. Two states reported failure on the part of their legislators to make appropriation for apiary inspection but stated that the mistake would probably result in larger appropriations at the next session. Reports from other states indicate increasing appropriations for this kind of work.

Dr. E. F. Phillips reported that he had on hand an unexpended balance of $14.25, left from membership dues received from members of the Association of Official Apiary Inspectors of the United States and Canada which was organized December, 1911, at Washington. After this association affiliated with the Association of Economic Entomologists as the Section of Apiary Inspection, it was impossible for eleven of these members to become members of the section because they were not entomologists. Dr. Phillips proposed that membership dues be returned to these eleven men and that the balance of $3.25

be turned over to the Secretary of the Association of Economic Entomologists. The Section expressed its approval of this plan.

Dr. E. F. Phillips, of Washington, D. C., was elected Chairman and N. E. Shaw, Columbus, Secretary, for the coming year. These selections were recommended to the nominating committee of the Association of Economic Entomologists.

N. E. Shaw.

ADDRESS OF THE CHAIRMAN

By Wilmon Newell, *College Station, Texas*

The Section of Apiary Inspection is a comparatively recent development in the Association of Economic Entomologists. This body was formally organized in Washington, D. C., in December, 1911, under the name of the "Association of Official Apiary Inspectors of the United States and Canada." A year later, at the Cleveland meeting, it affiliated with the Association of Economic Entomologists and received the rank of a section. A short but interesting program of the section was held at the Atlanta meeting a year ago.

The work of the economic entomologist is mainly one of conservation. It is his province to provide methods of protecting crops, fruits, etc., either in the course of their production or after they have been harvested. The conviction that this constituted the sole field of the economic entomologist was so firmly fixed that even the entomologists themselves did not regard the study of wealth-producing insects, such as the honey-bee, as a legitimate part of their work.

However, it must be conceded that the study of beneficial insects of every kind constitutes economic entomological work just as surely as does the study of injurious forms.

It was but appropriate, then, that entomologists, though somewhat tardily, should turn their attention to the development of the beekeeping industry and to the problems connected therewith. Six Experiment Stations, Minnesota, Iowa, Massachusetts, Oklahoma, Texas, and Ontario, Can., now operate experimental apiaries for the development of better methods of beekeeping and the Bureau of Entomology at Washington has done much in recent years to bring the beekeeping industry into the prominence which its importance merits.

The most important phase of this work has been the protection of bees against infectious and contagious diseases and many states now maintain, through their state entomological departments, an efficient apiary inspection system, not unlike the older system of nursery and orchard inspection. In states where this work has been in other hands

there is a growing inclination to transfer it to the entomological departments. This branch of entomological work is each year becoming of more and more importance and it is most appropriate that our program this evening should have as its opening number a report of progress from the various states.

The addition of apicultural inspection to the already heavy load of duties carried by the average economic entomologist has presented many new problems in efficiency. For example, the task of keeping adequate records, often with insufficient clerical help, without seriously hampering other lines of entomological work, is one which has been faced by most of our members. Proper correlation of the field work with that of the office also presents new questions for solution. A knowledge of the distribution of bee diseases, and the means by which they are disseminated, is of the utmost importance to the apiary inspector, for he who knows from whence the enemy is to come is more than half prepared to meet him.

These questions are to be discussed this evening by gentlemen who have not only given them long and careful consideration but who, by experience, have tested their own methods and found them not wanting.

THE DISTRIBUTION OF AMERICAN AND EUROPEAN FOUL BROOD IN THE UNITED STATES

By E. F. Phillips, *Washington, D. C.*

(*Withdrawn for publication elsewhere.*)

A SIMPLE RECORD SYSTEM FOR APIARY INSPECTION

By W. E. Britton, *New Haven, Conn.*

In Connecticut, the first apiary inspection law was passed by the legislature of 1909, but the measure went into effect so late in the season that no actual inspection work could be done before the summer of 1910. As the law provided that permanent records open to public inspection should be kept on file in the office of the State Entomologist, we were obliged to devise a system to meet the requirements of the situation.

Inspection reports filled out in the field are apt to become soiled and lack uniformity; names and addresses of beekeepers often vary in different reports; the writing is usually done hurriedly so that the reports are hardly suitable for filing as permanent records. After

giving some study to the matter the following system was devised, and has been in use ever since. Though perhaps not perfect, it is both simple and flexible, and has been found satisfactory.

The permanent office records are kept on ruled 5 x 8 inch cards. Each line holds the records of a year, and each card will answer for about fifteen years.

At the top of the card is typewritten the name and address of the beekeeper, care being taken to give accurately the name of the town and the mail address, which are often different near town boundaries and especially on rural free delivery routes.

The card is then cross-ruled and divided into twelve vertical columns with printed headings as follows: Date of Inspecton; Number of Colonies; Diseased with Foul Brood—American, European; Treatment Given; General Condition of Apiary; Date of 2nd Inspection; Condition at Time of 2nd Inspection; Experience in Beekeeping; Quarantine—Placed, Lifted; Name of Inspector.

These permanent records cards are filled out by the clerk in the office from the inspector's reports which are generally sent in once a week or perhaps twice a month. The inspector's report blanks contain: Name of Beekeeper; Town address; P. O. Address; Number of Colonies in Apiary; Number with Foul Brood (American or European); Other Troubles; Owner's Experience; Treatment Given; Date of Inspection; Date Quarantined; Date Released; Certificate Granted; and Name of Inspector. These are made up in booklets each containing 50 solid white pages for the originals, and alternating with them are 50 yellow sheets for the carbon copies. The yellow sheets are perforated and are torn out and sent to the office and the data copied upon the permanent record cards.

The record cards are punched for the round center rod, and are made out in duplicate, one set being arranged by towns and the other alphabetically.

For convenience in readily looking over the work of the season during its progress, each card in the town index on receiving a new record is marked at the top by one of Smith's steel signals. If the apiary was not found diseased a light blue signal is used. If foul brood of either kind is found in an apiary the card is marked with a light red signal. These signals show at a glance, the total number of inspections recorded for the year, the number in each town and the ratio between healthy and diseased apiaries. Before beginning the next season's work or after the year's report has been prepared, these signals are removed. Their legitimate use will often save much time, especially where it is otherwise necessary to examine every card in the index to acquire the needed information.

Some may object to this system on account of the possible danger of error in transcribing the data from the inspector's report to the permanent record cards. I believe that this is not a valid objection. Of course it means more work in the office, but the records are in so much better condition than they could possibly be if made out in the field that I believe that the extra labor is warranted.

Our chief mistakes usually occur in the names and addresses on the inspector's reports and we write to the inspector at once and the correction is made. Thus the copying record system really serves as a check on the reports of the inspector.

INSPECTION AS A UNIT IN THE MASSACHUSETTS APICULTURAL SERVICE

By Burton N. Gates, *Amherst, Mass.*

The apicultural work of Massachusetts, although it is new, is somewhat peculiar in that its several phases are centralized in one office. These are administered, however, under separate appropriations and by separate boards, or directors. The work of the State Board of Agriculture is specified by law as apiary inspection, and under this heading I will explain its several features. The Agricultural College work is divided into several parts. There is the apicultural work for regularly enrolled college students; investigational work for the Experiment Station; and several types of apicultural extension authorized and directed by the Extension Service. Besides these several groups, there is a considerable amount of both state and national associational detail which passes through the office. Schedules and programs for meetings and field days, the preparation of propaganda and news items may be mentioned by way of illustration.

Since the writer is frequently called upon to explain the organization of the beekeeping work as a whole, it may be well to mention first its scope under the heading of the College.

College.—To the regularly enrolled students, there are offered at present two courses. The first, intended primarily for juniors, is a general course, attempting to ground the student in the fundamentals of the subject. The second is primarily a senior course, and is intended to take up more special phases of the subject. It gives also an inkling of some of the larger problems confronting students of beekeeping, which require experimentation and affords some opportunity to acquire familiarity with experimental method.

Museum.—In connection with the teaching, there is maintained a beekeeping museum where already there have accumulated hundreds

and perhaps thousands of specimens, illustrative of natural history, apiarian products and equipment, both foreign and domestic. The purpose of the museum is to afford an opportunity for comparisons, to develop or stimulate improvements, for example adapted to a special purpose. Likewise, it shows up inferiority in mechanisms and devices, brands of supplies and products. Those persons of an inventive temperament are at liberty to compare inventions of the best and benefit accordingly. Perhaps this is more important than the accumulation of natural history material which is the more common purpose of a museum.

Library.—There is being accumulated also a beekeeping library aside from the author's collection. It is found desirable to gather and preserve the transient periodicals as well as supply-catalogs and lists. Such material is especially valuable to the research student.

The Apiary.—An apiary on a substantial and practical basis is a new feature in any college. Heretofore, agricultural colleges have shown but a passive interest in maintaining bees. Therefore the development of a demonstrational, yet practical working apiary, has required the working out for the first time, of a great many new features. Some of these as planned, and yet but partially practiced, aside from the keeping of fifty colonies of bees, are the bee garden where it is hoped to demonstrate some of the more important honey plants; and the workshop where hive construction is taught. In teaching the construction and building of hives, while it might not readily be presumed, the fundamentals of hive utilization are also brought forth. There is the honey room with its extraction equipment. Besides this, there will be developed a bottling equipment upon the most approved principles. The wax rendering laboratory is also another feature.

This is partially an item of the Extension Service, yet it is maintained apart from it. Its origin is recent and at first it was designed merely to demonstrate the principles of handling wax. Later it was found that vast quantities of old comb were being burned up by the beekeepers throughout the State. As a unit of the inspection service, it then became desirable to salvage these combs rather than to destroy them. Plans and facilities were prepared so that now beekeepers are at liberty to send their scrap wax and old combs to the College for rendering, at a slight cost. Naturally the more improved equipment of the institution obtains a higher percentage of wax than the beekeeper can get. It saves him then, both wax and labor, and reduces his costs. Already (and the wax rendering service has been in operation but a few months) the value of the wax rendered approaches one thousand dollars. This is an important advance, moreover, in the central-service-station idea.

Experiment Station.—The work for the Experiment Station need not be dwelt upon. Naturally it falls into the well-defined policies of such an institution. At present one of the problems concerns beeswax, an effort being made to determine the amount of wax in combs of different types, to the end of improving extraction processes. A number of other experimental problems are also in hand.

Extension Service.—For the extension service, the work may be grouped under short courses, conventions, fairs, itinerant schools and correspondence course. The extension work in beekeeping is so essentially new that efforts thus far are in nature experimental. The value and importance of extension schools is now proven. The itinerant school, however, has not yet been tried. The first will doubtless be held early in the spring of 1915. For several years, however, short courses have been given. These started with a special two-weeks beekeepers' school. This was essentially a cram course, the students' entire time being devoted to the one subject. The work consisted of lectures, demonstrations, laboratory work and excursions. At the end of two weeks, a convention for one or two days at which prominent apiarists and lecturers were in attendance, was held. This kind of a course, however, has its limitations, and in some ways the ten-weeks winter school in beekeeping has proven more desirable. It is given in conjunction with other subjects, as, for instance, poultry keeping, horticulture, or pomology, and is directly correlated with the trend of the student's work. This course is terminated by Farmers' Week, during which there is a Beekeepers' Day. It is one of the convention days in beekeeping for the State.

For the first time, in the fall of 1914, the Extension Service offered a beekeeping exhibit for fairs. A ton or more of material has been cased and prepared for this exhibition purpose; it has been found to meet with decided approval among the people of the State. Besides a static exhibit of hives and implements, natural history specimens and the like, there is a dynamic feature, namely, the display of bees and queens, together with demonstrations of the handling of bees. It is needless to say that such a feature is more or less sensational, yet it has a definite educational value. Aside from the demonstrational work at fairs, there have been held special demonstrations to meet local conditions, which might be termed emergency field days or conventions. This phase of apicultural extension is of decided worth and is capable of considerable expansion. It takes the College directly to the beekeeper.

The State Board of Agriculture: Apiary Inspection.—Apiary inspection is by no means the least important of the State's duties to the beekeepers. As might be inferred in Massachusetts, it forms an

integral part of the whole. The inspection work, however, is not disassociated from the work at the College any more than the converse is true. The work of the state being a unit requires that all its features be interlocking; the College helps the inspection work and the inspection is essential to the college.

At present the law allows but four inspectors, three of whom are deputies, with an appropriation of $2,000 per annum. This is decidedly inadequate to satisfactorily meet the demands.

Inspection Policy.—Massachusetts, like most New England states, is exceedingly conservative. The beekeepers are zealous in demanding attention; therefore they cannot be skipped. It has been found that to go into any one locality and visit only a few of the beekeepers there, brings down a rain of complaints from the other beekeepers. Consequently the policy of inspection in Massachusetts is slightly different from that in some states, where it has been advocated that only such apiaries be visited as are known to be diseased or of enough commercial importance to warrant inspection. Directly opposed to this policy, Massachusetts inspection has been an apiary to apiary canvass, starting with a center or focus of infection. Gradually the inspector enlarges his territory from this central point by concentric circles, until the limit of infection is found. A map of the inspection work would show that relatively well-defined areas of infection occur. Of course there are some few scattering cases, which are gradually checked up. That this method applies in Massachusetts has been proven from the demands of the beekeepers and from the decrease of infection in given localities. I take, for illustration, the county of Berkshire, where beekeeping prospers particularly, and where, being against New York State, infection with European foul brood in 1910 and 1911 was very general. The beekeepers, too, were discouraged. They thought disease had come to stay. Now the disease is on the wane and beekeeping is on the climb. Apiaries are being enlarged. Moreover, beekeepers are of a better and more earnest type, as might be expected. The shiftless, let-alone beekeeper has had to go. A few more years doubtless will show greater improvement; but, the present status may be learned from the table below.

Comparative Table, Showing the Bee-Disease Status of Berkshire County, Mass., in 1914

Apiaries		*Colonies*	
Visited	Infected	Examined	Infected*
1911 154	70 or 45%	980	439 or 43%
1914 179	25 or 14%	1028	72 or 7%

*Entirely European foul brood in this County.

From this table it will be seen that of the apiaries visited in 1911 and 1914, the percentage of infected apiaries has dropped from 45 per cent to 14 per cent. Likewise, from the standpoint of the individual colonies, the percentage of infected colonies has dropped from 43 per cent to 7 per cent. This has a further significance in that there is an increase in the number of colonies which, though slight, must be interpreted with reference to the elimination of the smaller and less prosperous beekeepers. Some of the largest apiaries in the county showed in 1914 no disease whatever, although these yards were in sad condition previously.

Similar indications of improvement, even to the extent of exceeding the most optimistic anticipations of the beekeepers and inspectors, might be cited for other parts of the State. It should be acknowledged, however, that there are still some rather seriously infected localities, which it has been possible to reach only after the elimination of infection in territories already under subjection.

The writer is frequently asked to mention the more important features which have tended toward efficiency in Massachusetts inspection. They may be listed.

Records.—The record cards are individual for each apiary and beekeeper in the state. Being of the loose-leaf principle allows them to be kept as a vertical file. The record cards are issued directly to the inspectors when routing their territory. Thus the inspector has before him the complete history of each yard or apiarist and of every transaction concerning both, even to knowing whether he has bought or sold bees within or without the State. Complete records have repeatedly proven of inestimable service. In the long run they will also afford a comparative statistical study of the State. The inspectors are required to fill in data concerning spring count, winter loss, number of colonies examined, diseased, etc. It takes but little time to record such, but it is required that the entries be made *on the premises at the time of inspection*, and not later transcribed from a notebook. As soon as the inspection of a town is completed the records are returned to the office, where they are kept on file. Information gained by inspectors is held as confidential.

Report Card.—The inspectors have found a report card, which they term the "clean up" order, of considerable advantage. This is a printed form which when signed, causes the beekeeper to promise that he will obey the instructions of the inspector, either to clean up an unsanitary apiary, or to treat or destroy infected colonies, before a given date. It further provides that the beekeeper shall notify the office of having fulfilled these instructions. Space is afforded for the beekeeper to indicate his desire for publications which will be sent from

the office, upon receipt of his request. The detached portion of the "clean up" order, which is left with the beekeeper, he should mail to the office upon completion of his work. It bears a few practical suggestions concerning disease.

Interstate Shipments.—One of the particularly advantageous features is the control of interstate shipments. The legal provisions are that no colonies upon combs may be shipped into the state from a state where there is an inspector unless their healthfulness is certified by a state apiary inspector. This limits an objectionable policy, which has been termed the "dumping" of disease into Massachusetts. From states where there are no apiary inspectors, stock is received without certificate, but the recipient is expected to notify the inspector of apiaries of its arrival, thus enabling a subsequent inspection of the stock. Only one addition would be recommended, namely that transportation companies be obliged to notify the inspector of the arrival of all stock from without the State. It has been said that in so legislating, Massachusetts has placed an embargo upon bees, but this cannot justly be maintained because legitimate shipments are provided for. In watching the practicability of this feature of the law, it has been noticed that beekeepers have been less imposed upon than perhaps they would have been otherwise. No complaint, but rather approval is made by the beekeepers of the state. There is less likelihood, moreover, that the conscientious work of inspectors may be upset through some careless shipment of diseased stock.

Quarantine System.—Formerly it was not customary for states to quarantine apiaries found to be infected. This is now more general and need not be dwelt upon, except to say that it is an indispensable feature of an inspection law. It protects not only the inspector, who, by an unscrupulous beekeeper might be misled or deceived, but it also protects the well-meaning beekeeper and limits the person of ill-intent. It also holds infectious materials on the premises where found until they have been properly and satisfactorily disposed of. Moreover, it is not without its moral advantage in stimulating beekeepers to watch out for the occurrence of disease, which, when they are conversant, they may treat before the inspector arrives, thereby obviating quarantine. Morally, too, it stimulates prompt treatment of a quarantined apiary.

Forms.—Summarily, there are five forms used by the inspectors (the record card, which is good for a period of eight or ten years; the quarantine blank and the release blank; the "clean up" report used in unsanitary apiaries; and the report used in apiaries in which there is found infection). The writer will gladly send specimens of these forms to inquirers.

Proceedings of the Thirteenth Annual Meeting of the American Association of Official Horticultural Inspectors

The Thirteenth Annual Meeting of the American Association of Official Horticultural Inspectors was held in Philadelphia, Pa., December 29 and 30, 1914.

The first session was held in the parlors of the Hotel Walton, and was called to order at 8.00 p. m. by the Chairman, W. E. Britton, with J. G. Sanders, Secretary.

The second session was called to order at 10.00 a. m. Wednesday, December 30, in the Veterinary Building of the University of Pennsylvania.

Upwards of 75 inspectors and visitors were present at each session, including several members of the legislative committee of the American Association of Nurserymen who were invited to attend the meetings of the inspectors for our mutual benefit.

The following program was presented at the two sessions of the meetings:

PROGRAM

Tuesday, December 29, 1914—8.00 p. m.

1. Address of the Chairman, W. E. Britton, New Haven, Conn.
2. Important Insect Pests Collected on Imported Nursery Stock in 1914. *15 min.* E. R. Sasscer, Federal Horticultural Board, Washington, D. C.
3. Some Recent Insect Importations into New Jersey. *10 min.* H. B. Weiss, New Brunswick, N. J.

Informal Discussion of Question 1

Wednesday, December 30, 1914—10.00 a. m.

4. Prevention of Rabbit Injury to Young Apple Trees. *5 min.* E. N. Cory, College Park, Md.
5. The Training of a Nursery Inspector. *15 min.* R. Kent Beattie, Federal Horticultural Board, Washington, D. C.
6. The Missouri Inspection Service. *10 min.* L. Haseman, Columbia, Mo.
7. Essentials in Insect Control. (A Plea for Greater Simplicity.) *10 min.* T. J. Headlee, New Brunswick, N. J.

Informal Discussion of Questions 2, 3, 4, and 5

Election of Officers for 1915—Business.

8. A Model Nursery and Orchard Inspection Law. (Progress Report.) *15 min.* J. G. Sanders, Madison, Wis.

General Discussion led by Mr. Wm. Pitkin, Rochester, N. Y., Chairman of Committee on Legislation of the American Association of Nurserymen.

Questions

1. Should further importation of all nursery stock be prohibited by Federal law, except in very limited amount for experimental propagation by the United States Department of Agriculture?

2. What is the proper treatment for scale-infested premises in close proximity to nurseries?

3. Should we require fumigation of all susceptible nursery stock grown in states known to be generally infested with San José Scale?

4. By what means can the standard of efficiency of inspectors be raised?

5. Should horticultural inspectors furnish a bond?

SUMMARY OF PAPERS AND DISCUSSIONS

1. Address of the Chairman. Dr. Britton reviewed concisely the early work of inspection of nursery stock and the reasons therefor, outlining the method of introduction of the San José scale into the United States and more particularly into eastern United States. He recounted the various successive steps taken by state authorities to safeguard the growing and distribution of nursery stock. The quarantine and inspection of imported plant material was also discussed and reference was made to the necessity of greater uniformity in the inspection laws of the various states.

2. The paper on "Important Insect Pests Collected on Imported Nursery Stock in 1914" by Mr. E. R. Sasscer of the Federal Horticultural Board, Washington, D. C., provoked considerable discussion on the part of the inspectors present. It was urged by the members of the Federal Board present that all species of insects and fungous diseases found on imported plant material, even though they be common ones, be reported to the Federal Board since full reports are valuable in showing laxity of inspection, and ultimately formed a general argument against free and promiscuous importation of plant material.

Mr. Rogers asked for a bulletin describing the important pests likely to be found on imported plants, believing that such a handbook should be available to all inspectors whose duty it was to inspect imported material.

Mr. Marlatt reported progress on such a bulletin to be published by the department of agriculture, which probably would appear in the form of a handbook. Over 100 illustrations and much manuscript is already submitted and may be published within the next year. This publication will also include a treatise on the fungus and bacterial diseases concerned with imported plants, the manuscript for which is n course of preparation by Dr. Perley Spaulding.

Dr. Britton asked for information concerning the recently imported

"pine bud moth" to which Mr. Marlatt replied that a preliminary paper by Dr. A. D. Hopkins is available. Also that Mr. August Busck of the U. S. National Museum is preparing a bulletin on this new pest. Mr. Marlatt further stated that the imported species differs from the native spruce bud moth in that it works deeper into the twig, causing greater damage and the recovery of twigs is rare. It is already known from twelve different states although so far it is largely a nursery problem.

Mr. Sasscer reported that there is in course of preparation a list of imported pests, arranged according to host, which list will soon be issued as a letter of information.

Mr. Schoene stated briefly that there seemed little actual necessity for promiscuous importation from Europe of our own native species of plants or of species easily grown here.

3. In the paper on "Some Recent Insect Importations into New Jersey," H. B. Weiss, New Brunswick, among other pests, reported the finding of Argentine ants in a shipment from Germany in greenhouse plants, the certain identification of which was made by Dr. W. M. Wheeler. It is also reported that 198 egg masses of Gipsy Moth had been found at Rutherford, N. J., where the infestation has continued for two years or more. Immediate and drastic measures were carried out and it is believed that New Jersey is now freed from this pest.

Question 1 of the program was discussed at length during the remainder of the session. This discussion brought forth opinions from the various Federal and State Inspectors present, as well as from the nursery men who were in attendance at the meeting. Summarizing the discussion, it was the general opinion of the majority present that certain prohibitions on the promiscuous importation of plants could be made without seriously hampering the nursery trade, particularly if a certain date was set a year or two in advance after which the importation of certain plant material should be curtailed. There was further discussion relating to the possibility of propagating seedling stock in America advantageously and thus eliminate the possibility of introducing more pests on this class of importation. Opinions on this question were at considerable variance but there seemed to be a general feeling that our native conifers should be propagated in this country and that further importations of conifers could be prohibited without serious handicap.

In the Wednesday forenoon session the paper on the training of a nursery inspector, by R. Kent Beattie of the Federal Horticultural Board, brought forth considerable discussion regarding the training of the inspector and the value of inspection. Dr. Fernald stated that,

in his opinion, the value of an inspection depends absolutely on the training, care and experience of the inspector, and that on these personal factors hinge the entire value of inspection and the certificate which is granted. Dr. Fernald also reported the examination of 100 records of "blister rust" and that in no case had one been found on gooseberry, but that all of them were shown to be infections on currant.

Discussion of question 2, at this point, showed a general agreement that the inspector should have authority to inspect and clean up scale infested premises in close proximity to nurseries.

There was considerable variation in opinions regarding the fumigation of susceptible nursery stock which was grown in regions known to be generally infested with San José scale; and the complaint was made that many horticulturists strenuously objected to the planting of fumigated trees.

Question 4 brought forth the general feeling that the statement previously made by Dr. Fernald, appearing above, was the only practical solution of the efficiency of inspectors.

Question 5 relating to the bonding of inspectors provoked a short discussion which brought forth the general opinion that in case the chief inspector was required to furnish a thousand dollar bond, greater care and consideration of the stock and its condition and treatment would be observed; and further, that in case stock was illegally or unnecessarily destroyed, nurserymen might have some redress through proper court proceedings.

BUSINESS

Professor Symons moved that there should not be held a special summer meeting of the Horticultural Inspectors at the time of the summer meetings to be held in California, and that any papers relating to horticultural inspection be offered at the meeting of the Economic Entomologists. Carried.

The nominating committee nominated Prof. W. E. Rumsey of Morgantown, W. Va., for chairman of the next annual meeting and Prof. J. G. Sanders, Madison, Wisconsin, as secretary. These officers were unanimously elected.

The model nursery and inspection law, which was drawn up in November 1913 and was considered at the Atlanta meeting and reported back for further consideration, was considered and debated. Copies of this law, in its latest form, were available at the meeting but the copies presented did not contain the latest alterations made during the conference held the previous day with the legislative committee of the Association of Nurserymen.

After considerable discussion, it was moved by Prof. Symons that

"the Association approve the substance of the proposed bill and that a committee be appointed by the chair to consist of five members to approve the final wording of the bill. Said committee to have power to act." The committee appointed by the chair consisted of Messrs. Marlatt, O'Kane, Worsham, Gillette and Sanders.

SOME RECENT INSECT IMPORTATIONS INTO NEW JERSEY

By Harry B. Weiss, *New Brunswick, N. J.*

Inasmuch as the state of New Jersey imports from the various countries of Europe, Asia and South America, an average of 12,000 parcels of nursery stock every year, it is not surprising to find injurious forms coming over and in some instances becoming established. Scale insects are the most numerous of these importations, chief among which are *Coccus hesperidum* Linn. occurring on bay trees from Belgium, *Chrysomphalus dictyospermi* Morg. on palms from Belgium, *Hemichionaspis aspidistræ* Sign. on aspidistra and ferns from Belgium, *Diaspis boisduvalli* on orchids from England, *Targionia biformis* Ckll. on orchids from Venezuela and the United States of Colombia, *Pseudaonidia pœoniœ* Ckll. on azaleas from Japan and *Diaspis pentagona* Targ. on peach stock from Japan, also *Lepidosaphes ulmi* Linn. on boxwood from Holland.

Except in the case of greenhouse species which were established in New Jersey, all infested plants were destroyed. During the fall of 1911 ants were taken from the packing in a case of roses imported from Germany. Unfortunately they were overlooked until the spring of 1914 when they were sent to Dr. W. M. Wheeler who identified them as specimens of the Argentine ant, *Iridomyrmex humilis* Mayr, which has been such a plague in the southern states and in California and which has recently been introduced into South Africa and Portugal. Dr. Wheeler was at a loss to understand its occurrence in Germany unless it had happened to be living in greenhouses. It is a tropical species and of course unable to maintain itself out of doors in the northern states or in Germany. Systematic collections of ants were made in several of the largest greenhouses in the state especially where imported stock had been received in large quantities but no Argentine ants were discovered.

Another interesting capture was the taking of *Eucactophagus graphipterus* Champion during April 1914 in an orchid house at Summit, N. J. This large member of the family Calandridæ is a native of Costa Rica and the United States of Colombia. Mr. Schwarz who determined it said that only three specimens were known, one of which had been taken in a Connecticut greenhouse by Dr. Britton.

Ulex europea from England was found infested by *Apion ulicis*, a weevil injurious to the seeds. Members of this genus are found on other leguminous plants and it is one which should be guarded against.

A much more injurious imported beetle in the shape of *Myelophilus piniperda* Linn.[1] was noted by Dr. T. J. Headlee to have gained a slight foothold in a northern New Jersey nursery where it was found attacking Scotch Fir to the extent of boring out the tips of the central shoots. According to Ratzeburg, this beetle does two important kinds of injury. First it attacks for the purpose of breeding, already injured Scotch Fir and quickly brings about its death. Second, it bores out the terminal twigs of young coppice growth causing the tree to assume a crooked unsightly branching habit. The result of this second type of damage is much like that of the white pine weevil. According to Dr. Hopkins, it often does extensive damage to pine trees in Europe and for this reason the section in which it was discovered is being closely watched.

Another imported beetle, *Agrilus viridis* Linn. var. *fagi* Ratz.[2] was found during the past year extensively injuring roses, chiefly in nurseries, in four different places in northern New Jersey. The injurious work of the larva consists of a spiral band of channels in the sap wood over which forms a swelling or gall, above which of course the plant dies. It was found attacking standard roses and *Rosa rugosa* more than other varieties and infested blocks presented the appearance of having been burned over as early as the middle of August. Considering the nature of the injury, cutting and burning of the infested stems during the fall or winter seems to be the best method of control.

Still another unwelcome importation, not from Europe however, but from Florida was *Callopistria floridensis* Guen. known as the Florida Fern Caterpillar. This pest was found during September 1914 injuring ferns in greenhouses at opposite ends of the state and one of the firms in question undoubtedly purchased it in some stage other than the adult along with a shipment of ferns from Florida. It does considerable damage to various species of ferns and in this state has yielded successfully only to handpicking supplemented by trapping the moths. Considering the fact that it is such a troublesome species, it would pay ferngrowers to be on the watch for it when receiving ferns from other establishments.

The most serious finding of the year was made in November, by Government scouts, who discovered 198 egg masses of the gipsy moth, *Porthetria dispar* Linn., at Rutherford. The capture of a perfect male moth on August 1 by a local collector led to these men being placed in the field by Mr. Burgess. The infestation occurred in a small block of nursery evergreens used mostly for show purposes and was at least

[1] Determined by Dr. A. D. Hopkins.

[2] Determined by Mr. Chas. Kerrimans of Belgium.

two years old. It is supposed that the egg masses were brought in on New England stock although no definite proof of this is obtainable.

Unfortunately the funds at our disposal for inspection service are expended almost entirely in the inspection of nurseries and foreign stock, leaving practically nothing for the inspection of domestic stock. It is needless to state that prompt measures were taken with the infested area and the careful scouting of the surrounding area by the Government men led us to believe that New Jersey is still free from this pest.

In addition to injurious species, one will at times find beneficial forms being imported. However as a rule, these are few and far between. Egg masses of the praying mantis are not infrequently brought in on stock from Japan. During the past season, a large black carabid beetle was taken from a case of Japanese azaleas and Mr. Schwarz identified it as *Damaster blaptoides* Kollar. This is a rather rare species, the genus being peculiar to Japan. Its introduction into the United States would of course be highly desirable. *Pterostichus* (*Feronia*) *vulgaris* Linn.[1] another beneficial carabid beetle, very common in central Europe was taken on Holland stock and *Amara ovata* Fabr.[1] from packing around English stock. *Philonthus politus* Fabr.[1] of the family Staphylinidæ was also taken from English stock. The species of this genus live under dung or decaying vegetable matter, the larvæ being predaceous on soft insect larvæ, mostly Dipterous. This of course places it among the beneficial forms.

Various other species mostly injurious but as a rule of lesser importance are taken from imported stock every year. This includes white flies on azaleas from Belgium, ants from Holland and France, *Pseudococcus sp.* on palms and bay trees from Belgium, *Tingitid* eggs on rhododendrons from Holland and *Notolophus antiqua* egg masses also on Holland stock.

One fact stands out plain. In spite of elaborate inspection systems and careful, conscientious work, some injurious foreign species continue to creep in and become established.

CAGES AND METHODS OF STUDYING UNDERGROUND INSECTS[2]

By John J. Davis, *Lafayette, Indiana*

Our studies the past few years with *Lachnosterna* and related insects, whose immature stages are passed underground and which have a one- to four-year life-cycle, have given us an opportunity to determine the relative value of various cages.

[1] Determined by Mr. Schwarz.

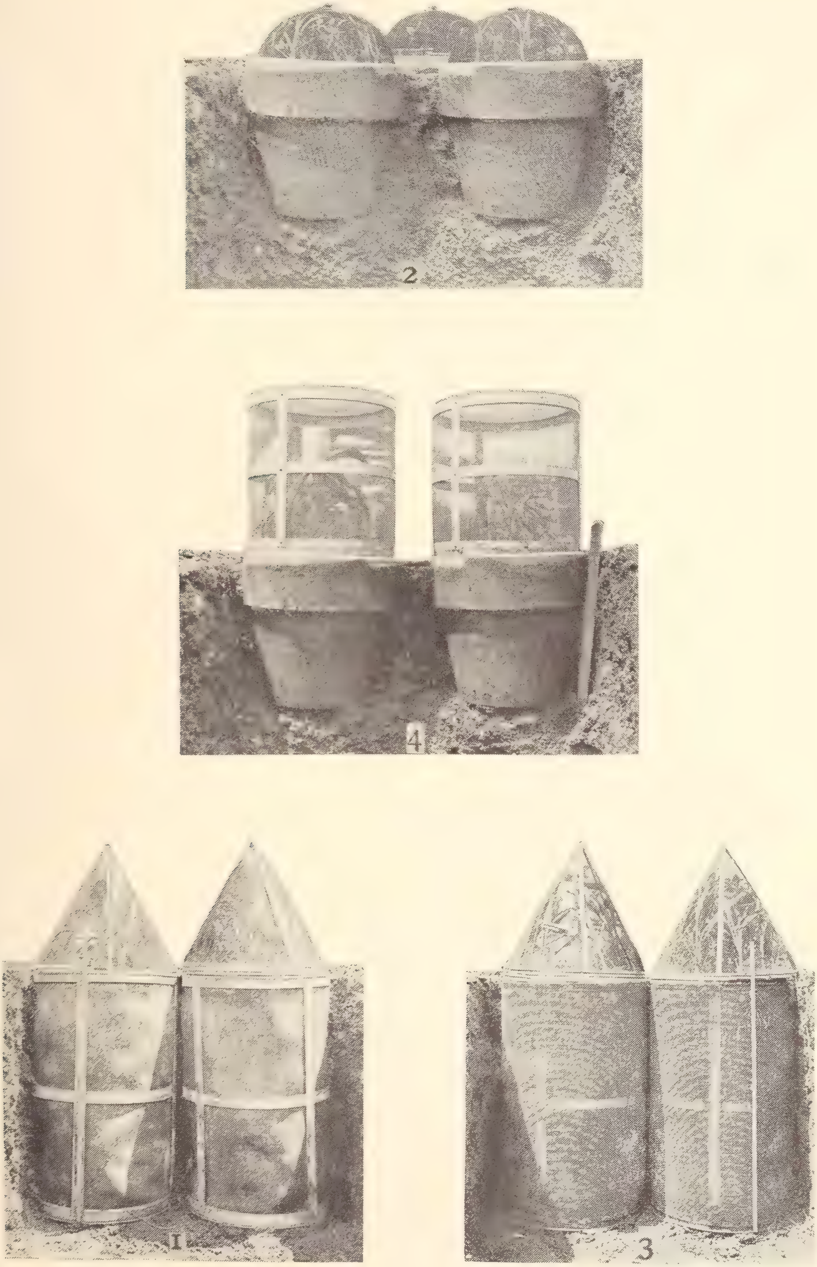
[2] Published by permission of the Chief of the Bureau of Entomology, United States Department of Agriculture.

In working out the complete life cycles the following general types of cages have been thoroughly tested with more or less satisfaction. 1. Ordinary standard size flower pots, 12, 15, and 16 inches respectively in diameter and depth. Red pots have proven more satisfactory than others for they do not crack and scale so badly from freezing and thawing (Plate 3, figs. 2 and 4). 2. Cylinder-shaped cages 20 inches in diameter and 4 feet deep, constructed of 18- and 20-mesh brass and bronze wire cloth, buried their entire depth and covered with a cone-shaped wire top. 3. Cylinder-shaped cans, 20 inches in diameter and $2\frac{1}{2}$ feet deep, made of galvanized iron with openings at the bottom for drainage. 4. Cylinder-shaped cans as No. 3 but with 4 square feet of 18- or 20-mesh brass or bronze cloth on sides, and the bottom of the same material. 5. Cylinder-shaped cages entirely of 18-mesh galvanized wire cloth (Gilbert and Bennett's "Pearl" wire) 20 inches in diameter and $2\frac{1}{2}$ feet deep, buried their entire depth, as the others, and covered with cone-shaped wire covers (Pl. 3, fig. 1). 6. Cylinder-shaped cages as No. 5 with an outer casing of heavy 6-mesh galvanized screen. (Pl. 3, fig. 3.) 7. Cages constructed of 20-inch tile, one and two tile deep and covered at the bottom with a durable wire screen. 8. Rectangular-shaped cages 5 x 8 feet in width and length, $2\frac{1}{2}$ feet deep below ground and $2\frac{1}{2}$ feet above ground, constructed of metal and wooden frames covered with 18-mesh pearl wire cloth (Pl. 4, fig. 5).[1]

Coleopterous larvæ with a three-year life-cycle were bred in all of the cages from egg to adult. Type No. 2 has been discarded since the galvanized wire will last sufficiently long and is not nearly so expensive as the brass or bronze cloth, and it has been definitely decided that cages need not be over $2\frac{1}{2}$ feet deep, at the most. The tile cages (No. 7) were no more satisfactory than the flower pots and were quite difficult to examine. Cages 5 and 6 were quite satisfactory but they were no more so than the flower pot cages and since they are considerably more expensive, they will hereafter be replaced largely by the latter. Cages 3 and 4 are somewhat cheaper than 5 and 6 and about as satisfactory but will be replaced hereafter by pot cages, for the reason just given. The large rectangular cages (No. 8) are quite satisfactory and are used to serve as checks on the smaller cages. Usually several species of the same genus are placed in each of these.

As already intimated, the flower pot cages, taking everything into consideration, are the most satisfactory, are easily handled, cheap, and well suited for underground insects. The pots are filled with good soil

[1] Cages of this style may be used for a double purpose, first as breeding cages for underground insects, and second for studying the seasonal life-history of aerial insects, such as the army worm (*Heliophila unipuncta*) as was done at Lafayette the past year.



Breeding Cages

which has been sifted to make certain it is free from insects, and seeded with a mixture of timothy and blue grass. Pieces of old corn stalks are usually included since the *young* grubs (*Lachnosterna, Cyclocephala, Anomola,* etc.) like to feed on decaying vegetation, and for grubs which are partially or wholly scavengers manure is added. Pots thus prepared are buried in the soil almost to their tops, and covered with cylinder-shaped tops as in the accompanying illustration (Pl. 3, fig. 4). Beetles, preferably pairs collected *in copula* are introduced and in the case of leaf-eating beetles, foliage is supplied as needed. It is necessary at various times to reseed or plant corn in the cages and, above all, it is essential to watch them and water as required, for they do not hold the moisture as does soil under natural conditions. It is equally necessary to water the wire cloth cylinder cages during the warmer and drier parts of the year for they do not retain the moisture any better, if as well, as the pots. During the winter, covers are removed and the pots covered with straw and this with strawy manure to a depth of one foot, which will gradually pack down to a comparatively thin layer (Pl. 5, fig. 9). Since the grubs do not, in flower pot cages, have an opportunity to go down to their normal depth for hibernation, this precaution is desirable and does not materially affect the conditions as found in nature. Cages such as these, which are used to obtain the total life-cycle, are examined for grubs only once or twice in a year in order to obtain specimens of the different aged grubs, and duplicate cages are invariably left undisturbed until the summer the beetles are to appear.

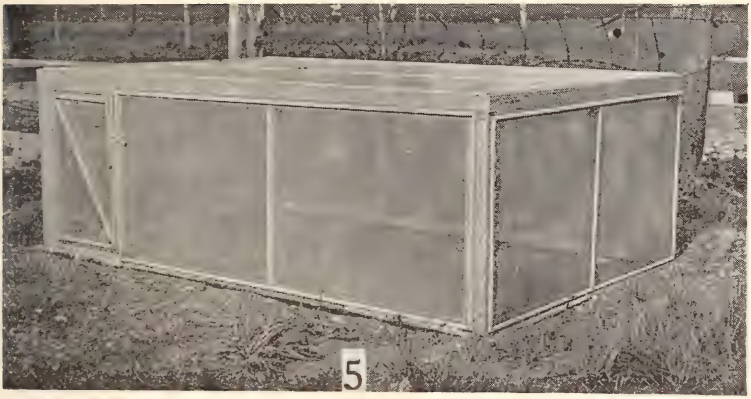
For obtaining eggs and records of individual pairs, 12-inch three-quarter or standard size pots filled with finely sifted soil are used. They are covered with wire screen tops within which single pairs are placed. The soil in these cages is not seeded nor are the pots sunk in the soil, but foliage is supplied as needed and a record kept of the amount of each kind of foliage eaten by the beetles. The pots are kept in a shaded or partially shaded location and every day or every few days the cages are sifted, using a 16-mesh riddle. If the soil contains the proper moisture content, the small balls of earth containing the eggs will remain intact, the loose soil sifting through.[1] The balls of earth are broken in half and the part containing the egg or eggs placed in boxes of soil, or small cavities, resembling the original egg cavity, are made in the boxes of earth and the egg placed therein, a damp camel's hair brush being used to dampen the eggs. The earth in the egg boxes is moistened as necessary and kept in a cool place comparable with natural soil conditions. We have also used shallow

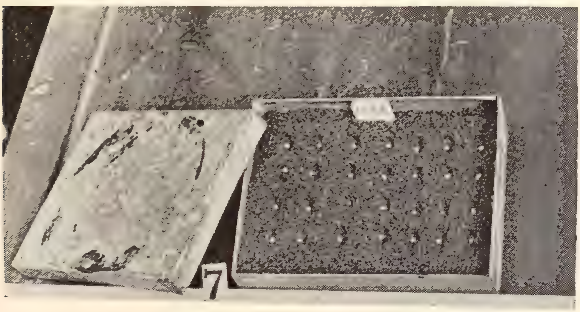
[1] This is the case with *Lachnosterna, Allorhina, Euphoria, Diplotaxis,* etc., but a few beetles do not make such a compact ball and the eggs appear in the riddle free.

pots known to dealers as fern pots (Pl. 4, fig. 6), for egg incubators but the tin boxes (Pl. 4, fig. 7), have given us more uniform satisfaction.

In order to study the habits of the grubs, their growth, molts, etc. one-ounce tin salve boxes are employed (Pl. 5, fig. 12). These are filled with soil, moistened to the proper degree, the grubs placed therein and a grain or two of wheat added. Extreme care is necessary in handling the young grubs and they must be disturbed as little as possible. Older grubs are fed grains of corn and are examined once a week, fresh soil and corn being added as needed. For convenience in handling we have trays (Pl. 5, figs. 10 and 11), made to hold 60 or 70 tin boxes and just the depth of the boxes and these are fitted in grooves, like the drawers of an insect cabinet, thus putting them in compact form and in such shape that any individual drawer or tin tray can be drawn out and examined without disturbing the others. By use of a blue pencil, such as is designed for writing on china, tin, etc., the cage number can be placed directly on the box and it will not be erased except by vigorous rubbing. As winter approaches all of the tin boxes are carefully examined to prepare the grubs for hibernation. All grain and vegetation is removed and the soil properly moistened. Watering, especially at this time of year, is an important item, time and experience alone enabling one to judge; it suffices to say that overwatering is the more natural and consequently to be guarded against. After the boxes are prepared for winter they are left in the tin trays which are placed one on top of the other, or are placed in pasteboard boxes holding a half gross or more, and buried in a compost heap to the depth of from one to two feet (Pl. 5, fig. 8).

The tin boxes above described are invaluable for many purposes. Grubs received from different localities and situations are reared in them with very little effort. When filled with sphagnum moss they make excellent receptacles for sending living grubs and other insects liable to injury in shipment. The past summer we successfully employed them for obtaining molts, length of instars, amounts of foliage eaten during different instars, etc., of the army worm (*Heliophila unipuncta*), one-ounce size being used up to the fifth molt, after which three-ounce boxes were used. They are simple, cheap, easily handled, and the molts readily determined, enabling us to run an extensive series of individuals. It is scarcely necessary to say that in the case of the army worm, check experiments were run to determine whether or not the tin boxes produced unnatural conditions for the larvæ, and in this case they did not, larvæ in the tins behaving, feeding and molting as did larvæ in several other kinds of cages. From our experience with tin boxes they are the simplest breeding cages available and, considering everything, will prove to be as invaluable to the entomologist as to the salve doctor.





Breeding Apparatus

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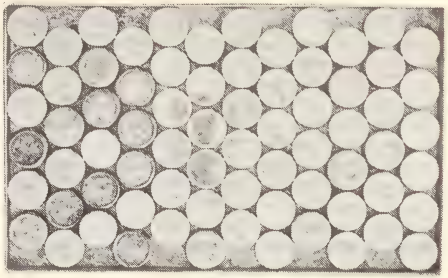

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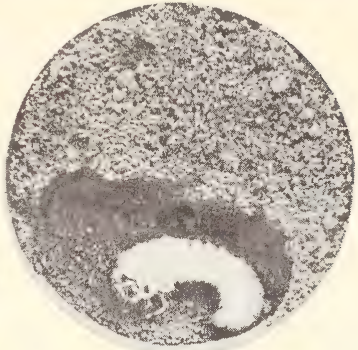

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Breeding Apparatus

Since this paper was written Mr. A. A. Girault has published an article on methods of rearing Scarabæid larvæ (Jour. Econ. Ent., Vol. 7, Dec. 1914, pp. 445–447). The author concludes that the underground Tower cages, which in this case are presumably underground cylinder cages made of wire gauze, are the most satisfactory, wooden boxes next and the flower pots third choice. Other circumstances not referred to in the table must have influenced these conclusions since they are not satisfactorily corroborated therein. Girault does not indicate the size of pots or Tower cages used and this might have a decided influence on the percentage of maturities, nor does he indicate the number of grubs per cage except in the case of a few examples and it is evident that up to a certain limit, the fewer the grubs the greater the percentage of maturities, other factors being equal. Furthermore, only larvæ within five months of pupation were used and in the case of the flower pots all were kept indoors (apparently not buried), hence it is impossible to make a satisfactory comparison between the results secured by Girault and those of the writer. In the case of half-grown grubs it is quite certain from our own results that the small individual tin boxes will prove as satisfactory, if not more so, than pots or other cages. Girault makes an excellent point and one which we corroborate when he says, "It would seem that the kind of cage mattered very little, providing they received good attention."

Explanation of Plates 3–5

Plate 3, fig. 1. Large underground breeding cage of 20-mesh Pearl wire cloth.

Fig. 2. 15-inch pots with wire screen dish cover tops.

Fig. 3. Large underground breeding cage of 20-mesh Pearl wire cloth covered with 6-mesh wire screen.

Fig. 4. 15-inch flower pot cage with cylinder-shaped tops.

Plate 4, fig. 5. 5 × 8 ft. underground breeding cage.

Fig. 6. Flower pot saucer egg cage.

Fig. 7. Tin box egg cage.

Plate 5, fig. 8. Compost heap in which certain cages are buried during the winter.

Fig. 9. Row of flower pot underground cages covered with strawy manure.

Figs. 10 and 11. Tray containing individual tin box cages.

Fig. 12. Individual tin boxes showing white grub in prepupal stage and cell constructed by it (natural size).

A PRELIMINARY LIST OF INSECTS WHICH HAVE WILT, WITH A COMPARATIVE STUDY OF THEIR POLYHEDRA[1]

By J. W. Chapman and R. W. Glaser

I. Description of Wilt

Although the nature of wilt in the gipsy moth will be thoroughly discussed by Glaser in a paper soon to be published, a restatement of its recognizable characteristics is necessary for a complete understanding of the discussion which is to follow; also because many persons are of the belief that wilt is peculiar to gipsy moth caterpillars only.

Clinical Picture

The wilt is characterized by the formation in the bodies of infected caterpillars of polyhedral-shaped, highly refractive, angular bodies, which have their origin in the nuclei of the tracheal matrix, hypodermal cells, fat cells and blood corpuscles. Later some of these burst and the poyhedra are set free in the blood. When death results they make up a great part of the saponified body tissues of the caterpillars. The caterpillars hang by their prolegs, become flaccid and their skin disrupts at the slightest touch. An examination immediately after death reveals few or no bacteria and no bad odor. The wilt appears in nature in both a chronic and an acute form. If, however, a dead caterpillar, on microscopic examination, shows no polyhedra it does not have wilt, even though all the gross symptoms may be present.

The point we wish to emphasize is that a consideration of both the external characteristics and the polyhedra is essential to a complete diagnosis of isolated or chronic cases of wilt; because there are a number of diseases of caterpillars, such as fungous, protozoan and possibly bacterial diseases, with which it might easily be confused under such conditions, even by the most experienced. If on the other hand the wilt has reached the epidemic form, it is highly improbable that it could be confused with anything else.

Following this rule of diagnosis we should look for wilt in all forms of insect life; for where it was thought to be rare it has proven to be common and widely distributed as will be seen from the following insects reported to be affected by it. For convenience of discussion and to prevent possible confusion we have divided them into three groups.

[1] Contribution from the Bureau of Entomology in coöperation with the Bussey Institution of Harvard University. (Bussey Institution No. 85.)

Group A contains, with the exception of the silkworm, the insects we have studied. Six families and ten species are represented.

Group B contains a list of insects reported to have polyhedral-sickness by the European investigators, Prowazek, Escherich, Wahl, Bolle, Bohm, etc.

Group C is made up of insects found in the United States that have a disease or diseases similar to wilt in many of its clinical aspects. With the exception of *Colias philodice* none of this group have been examined by us.

List of Species, with Their Distribution

Group A

I. Saturnidæ.
- 1. *Hemileuca olivia* Ckll.

II. Noctuidæ.
- 2. *Leucania unipuncta* Haw.
- 3. *Laphygma frugiperda* S. & A.

III. Dioptidæ.
- 4. *Phryganidia californica* Packard.

IV. Lymantriidæ.
- 5. *Porthetria dispar* L.
- 6. *Lymantria monacha* L.
- 7. *Orgyia leucostigma* A. & S.

V. Lasiocampidæ.
- 8. *Malacosoma americanum* Fabr.
- 9. *Malacosoma disstria* Hübner.

VI. Bombycidæ.
- 10. *Bombyx mori* L.

Group B

I. Sphingidæ.
- 11. *Deilephila* sp.
- 12. *Smerinthus atlanticus* Auct.

II. Saturnidæ.
- 13. *Antherea pernyi* Guer.
- 14. *Antherea yama* Guer.
- 15. *Antherea mylitta* Drur.
- 16. *Philosamia cynthia* Drur.
- 17. *Saturnia pavonia major* O.

III. Noctuidæ.
- 18. *Prodenia litosia*

IV. Lymantriidæ.
- 19. *Orgyia antiqua* L.

V. Notodontidæ.
- 20. *Harpyia bifida* Hubn.

VI. Geometridæ.
- 21. *Bupalus piniarius* L.

VII. Tortricidæ.
- 22. *Conchylis ambiguella* Hubn.

VIII. Tenthredinidæ.
- 23. *Lophyrus rufus* Ratz.

IX. Muscidæ.
- 24. *Calliphora vomitoria* L.

X. Dermestidæ.
- 25. *Dermestes lardarius* L.
- 26. *Anthrenus musæorum* L.

Group C

I. Pieridæ.
- 27. *Colias philodice* Godart.
- 28. *Eurymus eurytheme* Boisd.

II. Arctiidæ.
- 29. *Hyphantria cunea* Drury.

III. Noctuidæ.
- 30. *Alabama argillacea* Hubn.
- 31. *Heliothis obsoleta* Fab.
- 32. *Autographa gamma californica* Speyer.
- 33. *Autographa brassicæ* Riley[1]

IV. Notodontidæ.
- 34. *Heterocampa guttivitta* Wlk.

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[1] January 23, 1915. Polyhedra were found in a caterpillar of *Autographa brassicæ* Riley during the past week.

Distribution—Group A

One of the most interesting phases of wilt besides its occurrence in so many widely different species, is its geographical distribution. We have already called attention (Dec., 1913) to its almost general occurrence in the Nun moth caterpillars and silkworm in Europe, where it is commonly known as "Polyederkrankheit" or polyhedral sickness.

The Gipsy Moth

Glaser (1915) has shown that the wilt is present throughout the entire gipsy moth infested area in New England.

Apple Tent Caterpillar

Observations on the tent caterpillars which we also previously reported have not been so general as those of the gipsy moth. However, more attention was given to them the past summer and one point in particular, near Lunenburg, Mass., was kept under observation. This was one of the gipsy moth observation points and consisted of a tract of mixed forest of perhaps fifty acres, surrounded by a dense swampy growth of many acres in extent. It was in this low growth that the apple tent caterpillars suffered almost complete annihilation from wilt. It first appeared in a chronic form, a few dying here and there in the webs. These would sometimes be spun over by the remainder of the colony before others died. It became epidemic about the time of complete defoliation (May 28–31, 1914), and within a few days thousands of webs were covered with dead and dying caterpillars, most of which were distinctly strawberry red in color. We searched this area for living caterpillars at this time and only a few were found. All of these when examined showed polyhedra in their blood. They too died in a few days.

Forest Tent Caterpillar

Though the wilt was also reported to have occurred in many places in the Forest Tent caterpillar, neither of us have seen more than a few typical cases from the field. Many caterpillars were sent in by the field men but only a few of them proved to have typical wilt.

The Army Worm

An outbreak of the army worm on Long Island, Boston Harbor, during August, gave us an opportunity to determine if wilt also occurred in that species. A trip was made to the Island through the courtesy of the officers of the penal institution of the city. Several hundred caterpillars were collected. Nothing resembling wilt was seen at the

time though many were dead or dying. The next day a typical case of wilt developed in one of the stock trays in the laboratory. The caterpillar was flaccid, hung by its prolegs and the skin broke at the slightest touch. A thin grayish liquid oozed out which proved on examination to contain almost pure polyhedra. Other cases of wilt developed in these trays from time to time. A number of deaths were also caused by bacterial infection as the post-mortem examinations showed.

We have had shipments of army worms from Nantasket, Mass., Hagerstown, Md., and Norfolk, Va. That the wilt was present in all of these places was shown by the typical cases of wilt in the shipping boxes at the time of their arrival at the laboratory from these places. J. A. Hyslop, of the Bureau of Entomology, who is located in Maryland, shipped 350 caterpillars (isolated in separate pill boxes) at one time. These were from seven different broods. Brood number five had 52 caterpillars, 50 of which were dead when we received the shipment. The remaining two died before the next day. There were also 30 dead in the other six broods, making a total of 82 dead with wilt out of 350 caterpillars.

Prof. Franklin Sherman, Jr., of North Carolina, recently informed us, after we had described the wilt to him, that some such malady did a great deal towards checking an outbreak of the army worm in North Carolina the past summer.

We have been more recently informed concerning the appearance of the wilt in two other outbreaks of the army worm, one in Illinois and the other in Oklahoma.

The Tussock Moth

During 1911 we made observations on the Tussock moth on Boston Common. A disease appeared among the second generation caterpillars which almost completely destroyed them. It had all of the external appearances of wilt and was so considered by us at that time, though no microscopical examination of the caterpillars was made.

The Tussock moth has been so scarce in New England since then that we have been unable to verify the observations of 1911.[1] The abun-

[1] Since the above was written we found some of the dried Tussock moth caterpillars taken on Boston Common, Aug., 1911, which had been stored with other insect materials. We examined them and the polyhedra were found to be plentiful and as fresh in appearance as though they came from caterpillars of the past season.

December 22, 1914, we received a letter from J. S. Houser, Associate Entomologist at the Agricultural Experiment Station, Wooster, Ohio, in which he says of *O. leucostigma:* "The accompanying photograph was taken July 7 at the time the caterpillars were supposed to be transforming to the pupal stage. The plot was practically defoliated, and for this reason attracted my attention; but much to my surprise I was

dance of this insect the past summer in Washington, D. C., provided the longed-for opportunity. Mr. E. R. Sasscer, of the Bureau of Entomology, kindly consented to send us caterpillars. About five hundred second generation caterpillars arrived from him the latter part of August. Beyond a few crushed in transit they appeared healthy and in good condition. Attached to some leaves which had served as food were two first generation pupæ which had failed to mature. These were examined and found to be full of polyhedra. Two days later a caterpillar was found dead, hanging by the prolegs. When grasped by a pair of forceps, its prolegs were left clinging to the side of the box. The case was as typical as any we had seen in the gipsy moth and the polyhedra were just as plentiful. A few of these caterpillars died each day until less than one dozen pupated out of more than five hundred caterpillars.

The Oak Caterpillar, Phryganidia californica

Early last spring we received word from one of Professor Kellogg's students at Stanford saying, "The Oak caterpillars are dying with a disease similar to wilt." We wrote him for material which he kindly sent; and though in poor condition when we received it, we were able to confirm his observations. Polyhedra were found in abundance in the dead caterpillars. According to his description of the disease it completely controls this pest at times and like wilt does the most good when defoliation has almost taken place.

The Range Caterpillar

Mr. H. E. Smith of the division of Cereal and Forage investigation has, the past summer, been working on the Tachinid parasites of the range caterpillar at the Melrose Highlands Laboratory.

On learning that we had found the wilt in other species of caterpillars besides the gipsy moth, he sent us a few Range moth caterpillars, one of which showed typical wilt symptoms. It proved on examination to be a very typical case. Since this was the last of his stock we have not had an opportunity to examine others, and therefore cannot say whether the wilt occurs naturally in the field or not. We will have to wait another season to determine this point.

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unable to find any pupæ. Upon examination, the dead caterpillars were found everywhere clinging to the branches, and also occurring in great abundance on the ground beneath. Some few caterpillars were yet alive, but were very sluggish. I collected some of these and carried them home, but they all died apparently from wilt," etc.

Mr. Houser enclosed some of the caterpillars he collected at that time. The abundance of the polyhedra in these caterpillars shows that they died of wilt.

Distribution—Group B

The insects contained in this group are reported on the authority of European investigators, who in the course of their studies of the disease of the Nun moth and silkworm caterpillars, either found a similar disease in these other species or by inoculation with the virus of diseased Nun or silkworms produced a similar condition in them.

Though details are generally lacking, enough information, in case of the majority of the caterpillars, is given to dispel any doubts one may have that the observers were not dealing with true polyhedral diseases. However, in regard to the production of the polyhedral-sickness in the larvæ of beetles and flies we do not feel so confident. Without going into too minute detail we should like to know whether the wilt ever occurs in these insects naturally. Also if all the typical symptoms are manifested in these individuals as in caterpillars. Until this and other more detailed information is forthcoming, we cannot come to any decision on the matter, further than to say all our own efforts in this direction have resulted negatively.

Distribution—Group C

We believe the species in this group should be reported at this time because they are all of more or less economic importance and particularly because they have a caterpillar malady which has checked them considerably, if not completely controlled them at some time or other. The various observers who have worked on the life histories and habits of these pests or have studied some special outbreak of them have made special mention of these maladies and their possible importance as factors in controlling these pests.

In looking over the histories of these diseases and in some instances getting the information at first hand from the investigators themselves, we were impressed with the similarity of many of them to wilt. With the exception of *Colias philodice*, we have not examined any diseased caterpillars of this group. A few Colias caterpillars which we tried to infect by feeding them army worm wilt died. They did not show the typical wilt symptoms. However, on examination a few polyhedra were found. We are inclined to believe that their presence in the Colias caterpillars was due to the unsatisfactory manner of feeding. Some of the material may have dried on the skin of the caterpillars. It was then washed off when the caterpillars were crushed for examination. Until this experiment is repeated several times or the wilt is found naturally in this species we cannot accept these results as final.

Comparative Study of Polyhedra

The question now arises whether or not there is more than one disease in the condition known as wilt. In Europe, as we have already pointed out, in a previous paper (Dec., 1913), there is a tendency to diagnose insect diseases, where polyhedra are present, as "Polyederkrankheit" or polyhedra-sickness. The idea is excellent, for though the diseases may not be identical they are similar in many respects[1] and until we know more about their cause certainly no harm can come from grouping them in this way.

We have adopted this scheme as will be seen from the preceding list of insects known to have polyhedra, and we have used wilt synonymously with "Polyederkrankheit."

Returning now to the question whether or not there is more than one disease concerned with wilt. We undertook a comparative study of the polyhedra in the different species of caterpillars: first, to see what light if any could be thrown on this phase of the problem; second, if by such a study we might determine the relation of the polyhedra to wilt.

We proceeded as follows: Smears were made either from fresh or dried wilt material. These were dried, fixed by passing through a flame, and stained by Giemsa's method. Five fields, of ten adjacent polyhedra each were drawn by camera lucida from each slide (one from each of the four corners and one from the center). These were drawn at the same magnification and at the height of the stage of the microscope. A stage micrometer was also projected and drawn. All measurements were then made with this enlarged scale. This projected scale was afterwards checked with measurements by an eyepiece micrometer.

We are not able at this time to present polyhedra from all the species named in group A. Unfortunately the few specimens of wilt of the Range caterpillar and army worm which we examined were not preserved. We can say however they differed in no material way from the polyhedra of the other eight species we have presented. (See Pl. 6, figs. 1–8).

As to the first part of the question. We must admit the comparative study of the polyhedra has added little of positive value; for with the exception of the silkworm caterpillars (Pl. 6, fig. 4, after Prowazek) which are distinctly rhomboidal, seldom pentagonal or hexagonal, there exists a striking similarity in shape between the polyhedra of the other seven species. If it is true that some of the polyhedra are more

[1] (1) Have polyhedra, (2) become flaccid, (3) hang by the prolegs, (4) body tissues become saponified, (5) and there is both a chronic and acute type in nature.

angular than others but with the possible exception of the tent caterpillars, this is characteristic of individual polyhedra in the same caterpillars, where they may vary from an almost spherical to a decidedly angular form.

Another striking fact is the great difference in size between the polyhedra in the different species studied. (Pl. 6, figs. 12–14.) Taking the average of five microscopic fields in each species studied, the polyhedra of the gipsy moth are the largest, measuring 3.4μ in diameter and those of the tussock moth the smallest, measuring 1.64μ in diameter. The polyhedra of the other species are intermediate in size. Glaser in his study of the polyhedra of the gipsy moth caterpillars found some measuring as much as 15μ in diameter, while in the same caterpillar there were many measuring 1.5μ and 2μ in diameter with all possible gradations between these two extremes.

As to the second part of the question, what relation have the polyhedra to wilt? We have previously stated (Dec., 1913) that the polyhedra were reaction products, a view also held by many European investigators. This view we further believe is strengthened by the present study of the polyhedra.

A further study was made of some polyhedra taken from caterpillars which died in experiments of cross infection. (Pl. 6, figs. 9–11.) That is, apple tent caterpillars were fed with gipsy moth wilt and gipsy moth caterpillars were fed with Nun wilt. A number of such infections were tried but the reciprocal infections were not made. Until this is done we cannot express a definite opinion on the results we have obtained so far. We present it more to call attention to or to show what might be done in the future in an experimental way, that might give the solution to the problem.

We wish at this time to thank all those who have in any way aided us in this work; especially those who have sent us material from the field.

Summary and Conclusions

1. Wilt occurs in many widely different species of insects.

2. The clinical aspects of wilt are very similar in all the species of caterpillars studied by us.

3. Wilt first appears in a chronic form, as conditions become more unfavorable it becomes acute, and finally terminates in a general epidemic.

4. There is a striking similarity in shape between the polyhedra of the different species of caterpillars given in Group A.

5. The polyhedra in the different species vary greatly in size.

6. The great difference in size which exists between polyhedra in the same caterpillar tends to strengthen our view that the polyhedra are reaction bodies.

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Explanation of Plate 6

Note.—Each figure consists of one microscopic field of ten adjacent polyhedra. Two measurements are given under each figure. The first refers to the average size of the ten polyhedra given in each figure. The second is the average of five such microscopic fields.

Fig. 1. Polyhedra of a Gipsy moth caterpillar.
(Average size 3.4μ and 3.39μ)

Fig. 2. Polyhedra of a Nun moth caterpillar.
(Average size 2.65μ and 2.43μ)

Fig. 3. Polyhedra of a Forest tent caterpillar.
(Average size 2.6μ and 2.5μ)

Fig. 4. Polyhedra of a silkworm.
(After Prowazek) Mag. 1400 diam.

Fig. 5. Polyhedra of an Apple tent caterpillar.
(Average size 2.05μ and 2.2μ)

Fig. 6. Polyhedra of a Tussock moth caterpillar.
(Average size 1.5μ and 1.64μ)

Fig. 7. Polyhedra of an army worm.
(Average size 2.3μ and 1.88μ)

Fig. 8. Polyhedra of a Phryganidia caterpillar.
(Average size 1.6μ)

Fig. 9. Polyhedra of a Gipsy moth caterpillar fed Nun wilt.
(Average size 2.5μ and 2.1μ)
Fig. 10. Polyhedra of a Gipsy moth fed Phryganidia wilt.
(Average size 2.15μ and 2.1μ)
Fig. 11. Polyhedra of an Apple tent caterpillar fed Gipsy moth wilt.
(Average size 2.35μ and 2.2μ)
Fig. 12. Polyhedra of a Gipsy moth caterpillar.
(Showing two extremes)
Fig. 13. Polyhedra of an Apple tent caterpillar.
(Showing two extremes)
Fig. 14. Polyhedra of a Forest tent caterpillar.
(Showing two extremes)

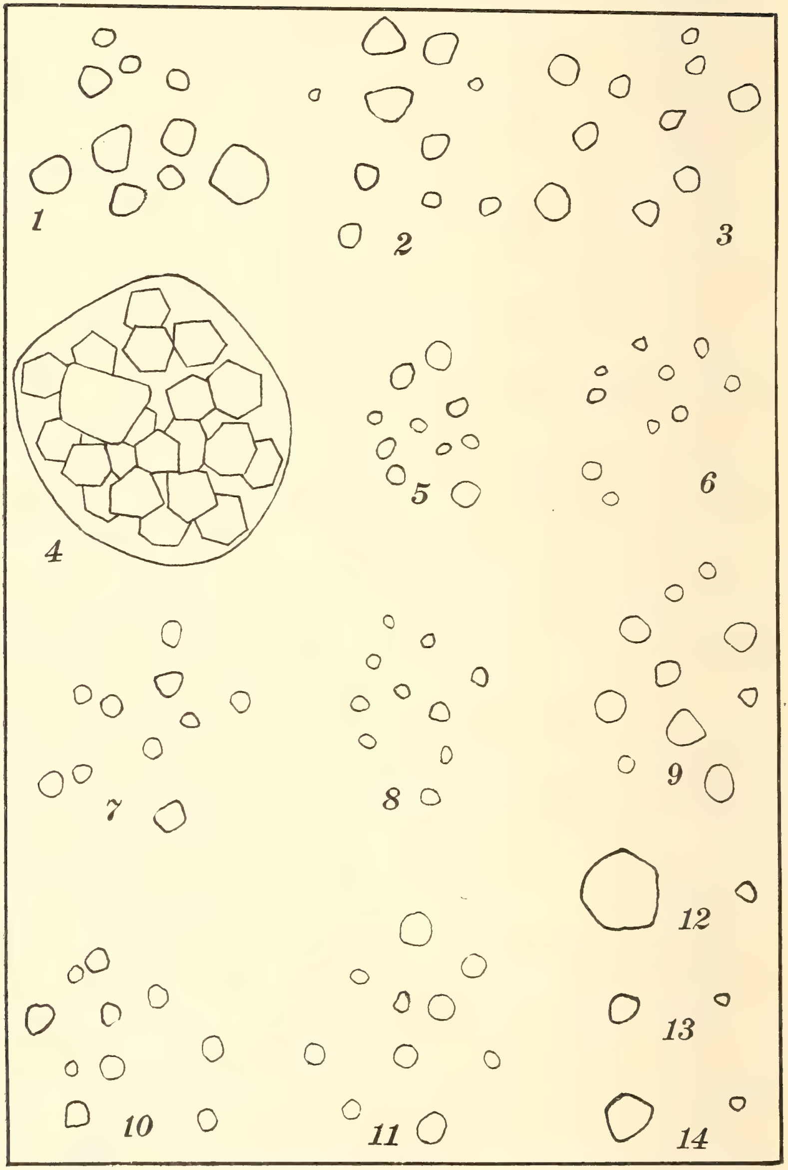
Drawn by camera lucida. (Ocular 6, Oil immersion $\frac{1}{12}$, tube length 160 mm.)

MYCODIPLOSIS MACGREGORI N. SP.

By E. P. Felt, *Albany, N. Y.*

The small midge described below was reared July 16, 1914, by Mr. E. A. MacGregor, Batesburg, S. C., from red spider on cotton, and at the time of rearing it was supposed to be identical with *Arthrocnodax carolina* Felt. This new species runs in our keys to *M: tsugæ* Felt, from which it may be easily separated by the equal and shorter stems of the fifth antennal segment and marked differences in the male genitalia.

Male. Length 1.2 mm. Antennæ one-fourth longer than the body, sparsely haired; fuscous yellowish; 14 segments, the fifth having the two portions of the stem nearly equal, each with a length one-half greater than its diameter; terminal segment with the basal enlargement oblate, the basal portion of the stem slender and with a length about twice its diameter, the distal enlargement stout, with a length one-half greater than its diameter and roundly tapering to an irregular, finger-like process less than one-half the length of the distal enlargement. Palpi; first segment irregular, the second with a length one-half greater than its diameter, the third one-half longer than the second, more slender, the fourth nearly twice the length of the third and somewhat compressed. Mesonotum fuscous yellowish. Scutellum and postscutellum yellowish. Abdomen light fuscous yellowish, the genitalia slightly fuscous. Wings hyaline. Halteres whitish transparent. Coxae and femora mostly pale yellowish, the tibiæ slightly darker and the tarsi a light straw; claws slender, evenly curved, the anterior and mid claws unidentate; pulvilli reduced, about two-thirds the length of the claws. Genitalia; basal clasp segment long, slender; terminal clasp segment rather short, stout, nearly straight, the dorsal plate short, deeply and roundly emarginate, the lobes tapering to a broadly roundly apex; ventral plate moderately long, tapering at the basal third, the distal portion of the sides nearly parallel, the apex broadly rounded and with two pairs of large, latero-posterior setæ; style long, slender, acute. Type Cecid. a2601.



M. T. Sheerin.

POLYHEDRA OF VARIOUS CATERPILLARS

A NEW SARCOPHAGA PARASITIC ON ALLORHINA NITIDA[1]

By J. M. ALDRICH, *Assistant in Cereal and Forage Insect Investigations, U. S. Bureau of Entomology, Lafayette, Ind.*

The publication of the following new species is desired in order that it may be referred to in a forthcoming article on the host.

Sarcophaga utilis new species.

♂. Robust black species with first vein bare, dorsocentrals much reduced and hardly differentiated except the hindmost two pairs, no acrostichals except the prescutellar pair, hind tibiæ not with long, erect villosity; and hypopygium red except for an indistinct blackish band across the middle of the first segment.

Head broad, the front at narrowest equal to $\frac{3}{4}$ of one eye, black above, the frontal stripe wide, black; lower part of the parafrontals together with the parafacials and anterior part of bucca rather grayish-yellow pollinose, a darker reflecting spot laterally from root of antennæ; beard mixed black and yellowish; bucca about half the eye-height in profile view; proboscis ordinary, palpi black; vibrissæ inserted well above oral margin, almost on a level with lower edge of eye. Outer vertical bristle well developed, almost like inner; three fairly regular rows of black cilia behind the compound eye; parafacials less than half as wide as median portion of face, with an oblique row of small bristles close to orbit and a few scattering; antennæ entirely black, third joint rather short and wide, twice the length of the second; arista loosely plumose for three-fifths of its length.

Thorax black, gray-pollinose, with the usual three black, sub-shining stripes, of which the middle one broadens out on the scutellum and is accompanied anteriorly by a fine line each side; another pair of stripes on the sides of the mesonotum, abbreviated in front, extend to the metanotum; pleuræ lightly pollinose, mostly blackish; scutellum large, with only two lateral pairs and a smallish apical pair of macrochætæ, together with a medium-sized subdiscal pair; halteres yellow, the stem and base of knob brownish; calypters white.

Fig. 9.—*Sarcophaga utilis* n. sp., male genitalia.

Abdomen gray-pollinose with the usual tessellated appearance, when viewed from behind showing three longitudinal blackish stripes; the hind margin of the fourth segment red in ground color; second segment without median marginal macrochætæ, third with a single pair, fourth with a row of about 18 across the dorsum.

The hypopygium normally retracted is rather large, red, the first segment more or less blackish on the base of the exposed part (really the middle), without row of bristles apically; second segment red, globose, with long blackish hair, more dense about the forceps. When unfolded the genitalia usually (in seven of eight examined) have the terminal part of the penis enveloped in a gelatinous mass, so that its structure cannot be made out; the accompanying drawing is made from a specimen that had been boiled in water, which successfully freed it from this substance. The long, abundant, backward-directed hair is omitted from the main part of the forceps. The drawing was made shortly after boiling, while the specimen was plump, but it

[1] Published by permission of the Chief of the Bureau of Entomology.

did not undergo much change in drying. The two apical sharp points of the penis are paired structures, as in fact all the other parts shown are. The tips of the forceps are very characteristic, being covered with erect, short, stiff hairs so that only a little of the black apex is visible; the rest of the forceps before the erect hairs is red in color.

Wings subhyaline, small crossvein not clouded, third vein bristly halfway to it or sometimes a little more; apical cell rather widely open; epaulet black, subepaulet pale yellow. Legs entirely black; pulvilli blackish, large but shriveled in drying, all claws elongated, fourth tarsal joint very short, less than half the fifth; hind femur with intermediate row of short bristles; middle femur with short posterior comb (below near tip).

Length to hypopygium, 8–9 mm.

♀. Front wider, equaling one eye; palpi more clavate; dorsocentrals a little better developed, four behind the suture, of which the anterior two are small; scutellum without apicals; tip of abdomen red beginning with the last third or more of the fourth segment; fifth segment deeply notched above and with an almost slit-like aperture behind, which is fringed with small bristles above; spiracles of fifth segment visible; claws and pulvilli of medium size, the latter dark yellow; hind femora without intermediate row of bristles; two pairs of orbital bristles.

Length, 7–13 mm.

Material examined: One male and one female, Norfolk, Va., Sept. 6 and 18, 1914, bred from pupa of *Allorhina nitida* by D. E. Fink; four males, Logansport, Ind., June 30, 1914 (Aldrich); two males, Lafayette, Ind., Sept. 16 and Oct. 9 (Aldrich); four males and one female, Tifton, Ga. (Hough Collection); four females, Opelousas, La. (same); one male, Agricultural College, Mich. (same); one female, Orlando, Fla. (same); and one from Pullman, Ill. (same).

The type is selected from the Logansport lot, but the drawing is from the paratype bred from Allorhina, as it showed after boiling the details of the penis, but was not in other respects suitable for the type.

Two males and two females (including type) deposited in the U. S. National Museum.

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The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engraving, may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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The Philadelphia meeting has become history. Those privileged to attend can hardly class the gathering as other than one of the most pleasant and profitable. The program was full but not so overcrowded that discussion was impractical and we have yet to learn of serious conflicts between the meetings of closely allied societies. Material progress was made with the Index of Economic Entomology. The plan has been carefully outlined and compilation has already started. There was a large increase in the membership and the finances of the Journal have been put upon more substantial basis. These are all creditable achievements and continuations of earlier adopted policies.

The design for an official seal for the Association of Economic Entomologists should receive careful consideration, and, as mentioned in the report of the Executive Committee, suggestions are desired by those with whom the final decision must lie. *Melanoplus spretus* has been suggested as particularly well qualified to occupy a prominent place on the seal. Its claims to this distinction may be briefly stated as follows: It is an important insect pest and its activities in earlier years resulted in the organization of the United States Entomological Commission—a pioneer in the exhaustive and fruitful studies so characteristic of the present day. The ravages of this insect raised the public estimation of applied or economic entomology from a tolerated and presumably somewhat beneficial calling to one of great practical importance—a rating abundantly justified in the developments of later years and attested by the present wonderfully efficient Federal Bureau of Entomology with its extended ramifications and the numerous state agencies employing skilled scientists in the study of insect

problems. The Rocky Mountain Locust really started the comprehensive entomological work of the present day and as a consequence was an important factor leading up to the organization of this Association. Furthermore, this insect is a characteristic American species with close allies so widely distributed throughout the world, that the casual observer in almost any country would associate the illustration of this species with familiar, injurious insects, even though he were unable to decipher the lettering on the seal.

Reviews

Some South Indian Insects and Other Animals of Importance, considered especially from an economic point of view, by T. Bainbridge Fletcher. Printed by the Superintendent, Government Press, Madras, India. 4to, p. i–xxi, 1–565, figs. 440, plates 50. 1914.

This large and rather weighty volume has an introduction of 74 pages dealing with the structure, classification and ecology of insects. The chapter on the control of insect pests is thoroughly modern and of interest to entomologists of America largely because of the emphasis laid upon hand collecting, a method particularly adapted to regions where there is an abundance of cheap labor. Here are also found excellent directions for the destruction of termites. The table of equivalent weights and measures is a valuable feature, especially where a double or treble system exists.

Chapters 12–23 deal with the principal crop pests, the groupings being somewhat unfamiliar to American eyes, namely, Caterpillar Pests of Crops, Grasshoppers, Crickets and Termites, to mention a few. There is a brief chapter on Household Insects, the paragraph dealing with wasps and bees having a distinctly local color. The disease-carrying insects naturally receive considerable attention and in the chapter one finds a list of Anopheles with the malaria and filaria carriers indicated and a tabulation of the principal diseases of India known to be carried by insects. The chapter on some other animals briefly discusses native mice, rats, fruit-eating bats, birds and snakes, to mention a few of the more important. This portion of the work ends with a list of the principal crops and their enemies.

The remainder of the volume, pages 264–547, consists of very brief accounts summarizing the biological data and arranged on a systematic basis. The numerous excellent text illustrations and the large series of colored plates, the latter mostly reproduced from *Indian Insect Life*, *Fasaler Poka* and *The Agricultural Journal of India* add greatly to the value of the work, a compilation which must prove of much service to workers in similar faunal regions.

Current Notes

Conducted by the Associate Editor

W. F. Turner, formerly assistant entomologist at the Alabama Station, is now at Vienna, Va.

The degree of doctor of philosophy was conferred on C. H. T. Townsend, October 29, 1914, by George Washington University.

An index to Circulars 101 to 173 of the Bureau of Entomology will soon be issued by the United States Department of Agriculture.

A. W. Jobbins-Pomeroy left for England on October 28. From London he will proceed to his post in Southern Nigeria in a short time.

Mr. W. W. Yothers, Bureau of Entomology, reports some very satisfactory demonstration orchard results in the control by sprays of the white fly and rust mite.

T. C. Barber, of the Experiment Station at Tucuman, Argentina, who has been in New Orleans for some weeks, is about to return to his post.

The work of Mr. J. R. Horton, Bureau of Entomology, in the New Orleans citrus district, principally with the Argentine ant, is developing control results of much promise.

Dr. Burton N. Gates, assistant professor of beekeeping at Amherst, Mass., is president of the National Beekeepers' Association, which meets February 16–18 at Denver, Colo.

Mr. C. H. Hadley, Jr., assistant entomologist at the New Hampshire College and Station, has resigned to accept a research position at Cornell University beginning January 1, 1915.

F. C. Bishopp, Bureau of Entomology, made an extended trip to the Dakotas and other states in connection with reports of heavy loss arising from insects which attack horses and cattle.

According to *Science* the following entomologists connected with the British Museum are serving at the front in the European war: Captain E. E. Austen (Diptera); Lieutenant N. D. Riley (Lepidoptera), and private K. G. Blair (Coleoptera).

R. W. Moreland and G. A. Runner, Bureau of Entomology, have been detailed to examine cotton fields in the vicinity of mills which have recently received foreign cottons, to determine whether the pink boll worm has become established.

C. L. Metcalf, for the past two years assistant entomologist in the State Department of Agriculture, Raleigh, North Carolina, resigned October first to accept the position of assistant professor of zoölogy and entomology at Ohio State University.

Mr. A. B. Duckett, scientific assistant, Bureau of Entomology, is engaged in a preliminary investigation of the so-called "Argentine corn weevil" in New York City and vicinity.

Mr. F. M. Wadley, temporary field assistant, Bureau of Entomology, during the summer, has returned to his duties as student at the State Agricultural College, Manhattan, Kansas.

Mr. H. M. Russell, Bureau of Entomology, has been granted indefinite leave of absence and expects to engage in farming in the vicinity of Phoenix, Ariz., where he was formerly stationed as entomological assistant.

Dr. Jas. A. Nelson, Bureau of Entomology, has completed his work on the development of the honeybee in the egg, on which investigation he has been engaged for some time. The paper will be published outside the Bureau.

Mr. Clarence R. Cleveland, a graduate of the University of Wisconsin, class of 1912, and assistant at Wisconsin Agricultural Experiment Station, has been appointed assistant in economic entomology at the Agricultural Experiment Station, Durham, N. H., in place of C. H. Hadley, Jr., resigned.

Mr. J. W. Bailey, Bureau of Entomology, who has been engaged for a large part of the season in investigations of the onion thrips and other insects in southern Texas, has returned to the Mississippi Agricultural College to resume his studies.

Mr. Thomas H. Jones has resigned his position at Rio Piedras, Porto Rico, and is stationed now at Baton Rouge, La., for the study of insects injurious to truck crops and stored products in Louisiana, in coöperation with Mr. E. S. Tucker, State Entomologist.

Mr. H. B. Scammell, of the Bureau of Entomology, will spend the winter at his headquarters, Pemberton, N. J., where he will make observations in connection with investigations of cranberry insects, giving special attention to questions connected with flooding of cranberry bogs, hibernation of cranberry insects, etc.

W. D. Pierce, Bureau of Entomology, investigated the dispersion of the boll weevil in the eastern part of the cotton belt early in October, and later began working along the same line west of the Mississippi River. The work in the east is being conducted by F. L. McDonough.

Mr. E. W. Rust, a graduate of Stanford University and for a period an assistant of Mr. Townsend's in Peru, has joined the inspection service of the Federal Horticultural Board, and will assist Mr. Sasscer and Mr. Sanford, the latter with the Bureau of Entomology, in this work.

H. A. Morgan, Dean of Agriculture in the University of Tennessee, made a trip to Louisiana during October at the request of the Bureau of Entomology. He visited the laboratories of Mound, Tallulah, and New Orleans. W. D. Hunter accompanied Professor Morgan on this trip and also visited the laboratories at Dallas and Victoria, Tex.

Professor E. Dwight Sanderson, Director of the Station and Dean of the College of Agriculture, West Virginia University, Morgantown, W. Va., has resigned to take effect September 1, 1915. Professor Sanderson was formerly entomologist of the New Hampshire Station. It is stated that he will take up graduate studies, in some subject other than entomology, in one of the large universities.

Mr. R. S. Woglum, Bureau of Entomology, presented at the recent Fruit Growers Convention at Los Angeles a very interesting paper on fruit injury during fumigation, showing that such injury is due principally to the hydrocyanic-acid gas entering through abrasion or accidental injury to the fruit rather than to the emanations of sulphuric acid.

Mr. J. D. Neuls, Bureau of Entomology, will conclude his life-history studies of date scale insects at Mecca by the end of this year and will then resume his former detail as an assistant in the citrus fruit laboratory at Pasadena with Mr. Woglum. This laboratory is the one formerly located at Whittier.

The work on the control of the house fly which has been under way in Washington during the season will be continued at New Orleans for several weeks. E. R. Barber will conduct the experiments at New Orleans. Mr. Hutchinson will complete the work at Washington and inaugurate an extended series of experiments to determine certain points about the hibernation of the fly.

The Bureau of Entomology has established a field station at West Springfield, Mass., about two miles from the center of Springfield and near the Connecticut line where investigations on cereal and forage crop insects will be conducted for New England. Mr. Harrison E. Smith has been placed in charge, and the buildings are now being erected and will be occupied by the Bureau in February.

The biological investigations in California of the grape *Phylloxera*, by the Bureau of Entomology, have now been pretty well completed, and Mr. W. M. Davidson will spend the winter in Washington, and will be engaged in the preparation of his report and necessary illustrations. The field work with remedial measures against the *Phylloxera* will be continued under the direction of Mr. R. L. Nougaret.

Mr. R. A. Cushman, Bureau of Entomology, who is engaged in an investigation of Hymenopterous parasites of the grape berry moth and other deciduous fruit insects at North East, Pa., is just now on a trip of investigation through Ohio, Indiana, Michigan, and will later visit the New England States to determine the distribution and seriousness of the apple seed Chalcis.

Mr. Wm. B. Parker, formerly entomological assistant engaged in investigations of insects injurious to sugar beets, hops and stored products, has severed his connection with the Bureau of Entomology and is now engaged as agricultural adviser of the University of California, with headquarters at Ventura, Cal. Mr. Roy E. Campbell assumes the position made vacant by Mr. Parker at the Sacramento station.

A greenhouse 16 feet 8 inches by 33 feet 10 inches has been built in the yard of the insectary of the Bureau of Entomology, to be used for experiments with greenhouse insects, including their control by means of fumigants and other remedies, and is expected to afford much greater opportunity for testing of insecticides against the more difficult pests to control.

During October a report on the occurrence of the pink boll worm of cotton at Madison, Fla., was received by the Bureau of Entomology. Immediate steps were taken by several offices in the department to eradicate the pest, but it was found on investigation by W. D. Pierce that the insect was *Batrachedra rileyi,* which occurred in unusual numbers in bolls affected by the anthracnose disease.

T. E. Holloway, Bureau of Entomology, reports some striking results from the experiments, to determine the effects of the burning of sugar-cane trash during the fall, on the sugar-cane borer and its parasites. The infestation by the borer was found to be much lighter where the trash was not burned. Presumably this is due to the fact that the burning of the trash destroys large numbers of parasites.

The outbreak of *Alabama argillacea* during the past season seems to have been the most severe for many years. In parts of Arkansas and Mississippi all of the green

portions of the cotton plants were destroyed in October. Ordinarily this outbreak would have attracted more attention. The peculiar conditions surrounding the cotton crop of the present year, however, were such that the insects' injury was not generally considered important.

The studies of the codling moth in Maine, carried out by the Bureau of Entomology during the past two years, under the direction of Messrs. E. H. Siegler and F. L. Simanton, have been completed and a report, giving the results of the work, will be prepared the present winter. It is planned to continue the laboratory in Maine, and to give special attention to investigations of the apple bud-moth and apple maggot.

Mr. E. R. Sasscer recently made a trip of inspection for the Federal Horticultural Board, including all the ports of entry along the Mexican border of the United States, in relation to the Mexican fruit-fly quarantine and also visited the special experiment stations under tropical and sub-tropical insects at Mecca and Pasadena, concluding his trip with an inspection of the Department's introduction garden at Chico, Cal., and after his return several introduction gardens in Florida.

The Annual Public Address of the Entomological Society of America was given Wednesday evening, December 30, by Dr. S. A. Forbes, State Entomologist of Illinois. His subject was "Ecological Foundations of Applied Entomology." The meeting was held in the lecture hall of the Academy of Natural Sciences. Following the address of Dr. Forbes a history of the Entomological Society of America was given by Dr. Henry Skinner of Philadelphia. Dr. Skinner also showed lantern slides of some of the early entomologists of America. The exercises were followed by a smoker given to all visiting entomologists by the entomologists of Philadelphia.

As a result of an examination held on April 14, for scientific assistant, and on June 3, for gypsy-moth assistants, the following 20 men were appointed in the Bureau of Entomology. Messrs. D. W. Jones, H. A. Preston, J. V. Schaffner, Jr., and W. B. Turner as scientific assistants; W. A. Collins, I. L. Bailey, C. W. Minott, H. W. Vinton, D. G. Murphy, E. A. Proctor, A. M. Wilcox, L. E. Gibson, K. W. Brown. H. R. Gooch, A. W. Young, W. A. Shinkwin, H. I. Winchester, H. E. Partridge, C. B. Russell and D. D. Landers as gypsy-moth assistants.

Mr. A. J. Ackerman, Bureau of Entomology, engaged in nursery insect investigations, West Chester, Pa., will make observations on fumigation methods as practiced in nurseries, paying especial attention to the construction of the fumigatorium, dosage and other questions of practical importance. Mr. Ackerman spent the late summer and fall at West Chester, Pa., in a careful study of the cause of stop-back of peach. His observations indicate that this is largely due to attack by the tarnished plant bug, and that the peach bud-mite *Tarsonemus waitei*, is perhaps but little, if at all, concerned.

On October 23, 1914, the Secretary of Agriculture declared a quarantine on all shipments of stone and quarry products from the gypsy-moth infested area in New England to uninfested territory. Material of this sort cannot be accepted by transportation companies unless it has been inspected and certified to be free from the gypsy moth. The work is being carried on in connection with the quarantine division of the gypsy-moth work by Mr. D. M. Rogers of Boston, Mass. This quarantine should effectively prevent the distribution of this dangerous insect on shipments of stone and quarry products, and it is an important step in the campaign which is being carried on to prevent its spread.

The apparatus used by the Bureau of Entomology in the investigation of bees in winter at the University of Pennsylvania, Philadelphia, during the past two winters has been moved and is now installed in the laboratory at Drummond, Md. A small room has been fitted up as a "bee cellar" in the basement, in which the temperature changes will be slow, the room being completely surrounded by planer shavings one foot thick. The wiring for the temperature readings is now being installed, thermo-couples being used for this purpose. The special scales for taking hourly weighings of a colony of bees during winter have been installed in a room on the first floor of the laboratory and arranged to weigh a colony in the basement.

D. L. Van Dine, of the Bureau of Entomology, has returned to Washington from his field station at Mound, La. During the season he made a careful study of the relation of malaria to agriculture. In this work detailed information was obtained regarding the incidence of malaria and the time loss in each of seventy-four families. A study was also made of mosquito density in the various classes of habitations and the breeding places in the immediate vicinity of the houses were determined. An experiment was performed on a considerable scale in removing the cans, bottles and other receptacles in the vicinity of the houses, and filling disused wells and old cisterns to determine the effect of such measures on mosquito density. Mr. Van Dine presented a paper on his work on malarial mosquitoes at the meeting of the Southern Medical Association at Richmond, Va., on November 9.

At the Boston Domestic Science and Pure Food Exposition held at Mechanics Building, Boston, Mass., during the month of October, a large Government exhibit was installed, showing the different activities of the United States Department of Agriculture. In connection with this exhibit a special display was prepared by the gypsy moth branch of the Bureau of Entomology. This included maps showing the infested district which is under quarantine on account of the gypsy moth and the brown-tail moth, and the areas where parasites have been colonized and recovered were also illustrated. Several trays containing live parasites breeding on gypsy moth eggs and a display of live *Calosoma* beetles were also included. Posters, and post cards, illustrating the gypsy moth and the brown-tail moth, together with some of their imported natural enemies, were distributed. A large number of visitors manifested a great deal of interest in the exhibit. Mr. R. Wooldridge, who is stationed at the Gypsy Moth Laboratory, Melrose Highlands, Mass., was in charge of the gypsy moth exhibit.

The Entomological Society of America elected the following persons as honorary fellows at its Philadelphia meeting: John Henry Comstock, Charles J. S. Bethune, Charles Henry Fernald, and Eugene Amandus Schwarz. The following were elected as fellows: Nathan Banks, J. Chester Bradley, W. E. Britton, C. T. Brues, H. T. Fernald, Glenn W. Herrick, J. S. Hine, O. A. Johannsen, A. L. Melander, A. P. Morse, P. J. Parrott, Edith M. Patch, A. L. Quaintance, J. A. G. Rehn, W. A. Riley, Annie Trumbull Slosson, E. M. Walker, H. F. Wickham, and E. B. Williamson. Dr. E. S. Van Dyke was elected as a local secretary to plan and look after the summer meeting of the society to be held in San Francisco in 1915. The executive committee recommended the preparation of a serial publication to be issued under the name of the Thomas Say Foundation, which will include catalogues of North American insects and monographs and memoirs of the same. A preliminary editorial committee consisting of J. M. Aldrich, Nathan Banks, Morgan Hebard, A. D. MacGillivray, and E. P. Van Duzee was appointed to look after the foundation of this serial. The society added one hundred and nine new members to its membership list.

A state meeting of the entomological workers in Ohio Institutions was held in the Botany and Zoölogy Building of Ohio State University, Columbus, Ohio, January 15. The business consisted of effecting a temporary organization and the question of permanent organization was discussed. The following papers were presented: Review of Entomological Work in Ohio, by Herbert Osborn; General Reports from Heads of Departments, Organizations; H. A. Gossard, Experiment Station; N. E. Shaw, Division of Orchard and Nursery Inspection; H. Osborn, Department of Zoology and Entomology. Ten-Minute Reports by Individual Investigators. (1) Experiment Station. J. S. Houser—Coccidæ of Ohio; R. D. Whitmarsh—*Nezara hilaris* and related species; W. H. Goodwin—Grapeberry Worm Control; J. L. King—Peach Borers; D. C. Mote—Ox Warble Fly. (2) Division of Nursery Inspection. E. J. Hoddy—Result of Tests of Insecticides and Fungicides; W. H. Evans—Inspection of Imported Nursery Stock; H. J. Speaker—Gypsy Moth Outbreak in Ohio; E. R. King—Apiary Inspection and Bee Diseases. (3) Department of Zoölogy and Entomology, Ohio State University. Jas. S. Hine—Apiculture Work, Diptera of Ohio; Wm. M. Barrows—Spiders of Ohio; C. L. Metcalf—Insects Related to Health; W. J. Kostir—The Catalogue of Ohio Orthoptera; C. J. Drake—Hemiptera-Heteroptera of Ohio. The meeting closed with a discussion of the projects to be continued and inaugurated during the coming year.

Scurfy Scale on Norway Maple (*Leucaspis japonica* Ckll.) Last fall we received from the Frost & Bartlett Company, Stamford, Conn., twigs and leaves of Norway maple and also privet showing a somewhat severe infestation by the above-named insect. It was reported as having caused considerable injury. The scale has much the shape of that of *Lepidosaphes ulmi* Linn., except that it is somewhat broader. It is a small species, being only 1.5 to 2 mm. long and a dull grayish white—pure white when the scale is first secreted. The twig submitted for examinaton was thickly infested, while small numbers of the scale insects had established themselves at the base of the principal leaf veins, with scattering individual sranged along the veins to the middle of the leaf. The absence of the tricarinate male scales characteristic of Chionaspis, serves at once to distinguish the common scurfy scale from this much rarer form.

The literature relating to this species is very scanty. It was described in 1897 by Professor Cockerell from specimens taken on broom, shipped from Japan, by Mr. Alex. Craw the preceding year, and subsequently it was found by Mr. Craw on *Magnolia souliana* and maples, species not indicated, from the same country. There are specimens in the New York State collection on orange, received from Mr. I. Kuwana, Japan, which, while closely allied, do not appear to be identical with the form taken on Norway maple.

E. P. Felt.

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[1] Withdrawn for publication elsewhere.

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Proceedings of the Twenty-seventh Annual Meeting of the American Association of Economic Entomologists

(Continued)

Afternoon session, Tuesday, December 29, 1914, 2.00 p. m.

President H. T. Fernald: We will now listen to a paper by W. W. Yothers.

SPRAYING SCHEME FOR THE CONTROL OF INSECT PESTS ON CITRUS TREES IN FLORIDA

By W. W. Yothers, *Bureau of Entomology, Orlando, Florida*

Of the total damage caused by insects to citrus in Florida more than 95 per cent may be attributed to six species. The most destructive is the citrus white fly (*Aleyrodes citri* R. & H.) which now infests nearly all the groves in the state. The second most destructive pest is the purple scale (*Lepidosaphes beckii* Newm.) which is found in greater or less numbers on every citrus tree in the state. According to my observations the rust mite (*Eriophyes oleivorus* Ashm.) ranks third. The Florida red scale (*Chrysomphalus aonidum* L.), the cloudy-winged white fly (*Aleyrodes nubifera* Berger) and the red spider (*Tetranychus sexmaculatus* Riley) are also of primary importance. It has been the object for several years to perfect a spraying scheme which would largely eliminate the damage caused by these pests. There are also several pests of secondary importance such as the woolly white fly (*Aleyrodes howardi* Q.) and the purple mite (*Tetranychus mytilaspidis* Riley), which this spraying scheme will also partially or completely control.

As a general proposition the time to spray for the control of all pests on citrus trees is when they are present in such numbers that,

if left to reproduce without artificial hindrance they would soon become injurious. In other words, the pests should be killed before they do much damage to either the tree or fruit. The pests should always be kept in such a state of subjection as to do little or no damage. In case the various pests to citrus trees are permitted to become so abundant as to cause damage, the profits which might be derived from artificial treatment, such as spraying with an insecticide, are, to a certain extent, lost. The life history and habits of nearly all pests on citrus trees are, fortunately, such that good and satisfactory results can be obtained any time the spray is applied. While such is the case there are times when it is opportune to spray. These periods come when the largest percentage of the insects is in the youngest stage, which is the one most easily killed.

The following spraying scheme has been used quite extensively for three summers and has generally given satisfactory results. It must be admitted, however, that no hard and fast scheme can be given, and the number of sprayings depends to a large extent on the thoroughness of the work.

I. Paraffin-Oil Emulsions; Government formula 1-50 or 1 per cent of oil—May. The main object of spraying at this time is to kill the white fly, scale insects, and to a large extent rust mites, although this treatment must not be relied upon to control the last. This spraying should be given after the adults of the first brood of white flies have disappeared and before the appearance of those of the second brood. The fruit should be an inch or more in diameter when the spraying is done. This treatment should be given before the beginning of the rainy season, so that the beneficial fungi will take care of those insects which are not killed by the spray.

II. Lime-Sulphur Solution, 32° Baumé, 1-50 to 1-75—June to July. The main object of this treatment is to kill rust mites and the opportune time for its application varies with the appearance of the maximum number of the rust mites. It should be applied before the mites get very abundant and before any russeting appears. It will also kill some scales and white flies, but is of little value for that purpose.

III. Paraffin-Oil Emulsions; Government formula 1-50 or 1 per cent of oil—August 25 to October 31. This is the second spraying for the white fly and scale insects. The object of spraying at this time is to kill all the white fly larvæ which are the progeny of the third and last brood. It is this brood which causes nearly all the damage from the white flies, and the earlier they are killed the better it is for the tree. This spraying also comes after all the beneficial fungi have done their work. This will also remove the sooty mold from the trees and

sufficiently from the fruit to permit the sun to color it up. Soda-sulphur 1-50 may be added to this spraying and this will increase its effectiveness in killing rust mites.

IV. LIME-SULPHUR SOLUTION, 32° Baumé, 1-50 to 1-75—November or December. The object of this spraying is to kill rust mites and it may or may not be necessary, depending on the abundance of the mites.

It may be necessary to spray for rust mites before No. 1 is given. In case the red spider becomes abundant enough to be injurious, a spraying with lime-sulphur solution should be given. It may also be necessary to spray three times with the oil sprays, in which case this treatment can be given in midsummer or in winter. If the red scale is very abundant, two sprayings with the oil emulsions should be given at intervals of about a month.

The paraffin-oil emulsion may be made according to directions given in Circular No. 168, Bureau of Entomology. In addition to the above there are two miscible oils on the market in Florida which are highly satisfactory. The soda-sulphur solution is made according to the standard formula, 30 pounds sulphur, 20 pounds caustic soda, 20 gallons of water. This tests about 16° Baumé and may be used 1-40 instead of lime-sulphur solution but it is not so effective in controlling rust mites. It has the advantage of the lime-sulphur solution in that it will mix with the oil emulsions. To follow the above scheme it will cost from 20 cents to 35 cents a year per tree. It costs one grower 20 cents for trees of about five-box capacity or 4 cents per box. Another did the work for 32 cents for eight-box trees or 4 cents per box. It cost several other growers 3, 3, 6, 7, and 8 cents per box respectively. A maximum figure would be 8 cents per box.

Even though this scheme is not strictly adhered to it will result in raising the grade of the fruit. The second grade will become first, the third will be largely eliminated, and the culls will almost disappear. The increase of production due to the increase in size of the fruit resulting from the elimination of the rust mite will be from 12½ to 25 per cent, amounting approximately to two million boxes. The devitalizing of the trees by the insects would be eliminated and the trees would then expend their vitality to produce fruit instead of nourishing insects. This would also increase the quantity and quality of the fruit and make a crop more certain from year to year, which would be crop insurance. It is a conservative estimate that the total benefits which would be derived, if this scheme was followed throughout the state, would be not far from an increase of production of a minimum of 25 per cent over that which is the result at the present time with a total de-

pendence on the beneficial parasitic fungi. The appearance of the fruit on the market would be vastly improved. The total dependence of the Florida citrus grower on natural enemies for the control of the pests on citrus trees is a delusion.

February 2, 1915.

PRESIDENT H. T. FERNALD: The next paper on the program will be read by P. J. Parrott.

AN ANALYSIS OF SPRAYING METHODS AGAINST THE CODLING MOTH

By P. J. PARROTT

One who has at heart the permanent prosperity, extension and normal development of fruit-growing in New York can hardly fail to be impressed with two facts: (1) The increased planting of apple trees, so that the care of orchards frequently over-shadows all other farm operations, resulting in an unbalanced state of farming; and (2) the growing necessity of more frequent and thorough applications of spraying mixtures. In addition to scab, scale and codling moth, it is now the lot of many orchardists to have to contend against fruit-puncturing capsids and leaf and fruit-infesting aphides; and spraying for these has become a regular part of the routine prescribed by the latest and most approved spraying schedule. The cost for spray materials is also increasing. Formerly lime-sulphur and arsenate of lead sufficed for the principal ills that the apple is heir to, but now the grower must needs use lime-sulphur and lead, plus other substances; and according to present usage nicotine is the most popular third constituent in the combination of spraying materials.

Individually and collectively the growers of New York are confronted with what may prove to be a great economic problem. In addition to the necessity of maintaining a high state of culture at increasing expense, they are apparently facing a period of diminishing returns. As a result more serious thought than ever before is being given to a study of methods of producing maximum yields of high-grade fruit at minimum cost. A partial solution of the dilemma is to improve spraying practices, at least as to the character, if not number, of the treatments. In spite of present methods, injurious insects are responsible for great reductions in financial returns. Moreover, in addition to direct losses, failure to maintain a high level of spraying practices may have the effect of neutralizing, if not actually destroying any benefit by other standard operations, as pruning, thinning, cultivation, etc., so essential today for the upkeep and

profitable production of the orchard. The objection to such a proposition by the average orchardist at first thought is, I fancy, that of cost; it being urged that most growers are already putting more into this operation than can be afforded, and one which, in addition to other objectionable features, calls for a cash outlay. A study of orchards under Station control suggests that the problem is in reality not so much a matter of cost as a matter of time,—to find time to spray the trees thoroughly at each critical period, and yet not neglect other orchard operations or other crops when they too demand proper attention.

As to expensiveness of spraying, the Auchter[1] orchard, now in its fourth decade, has yielded the Station during the past decennium a net profit per year of $120.60 per acre. On the cost sheet for a barrel of apples are nine items of expense amounting to $1.29, which covers the growing, harvesting and delivery of the fruit to the railroad station. In order of importance as regards extent, spraying ranks as fifth in the list, and amounts to only $7\frac{1}{2}$ per cent of the whole cost involved in producing a barrel of apples for the market. This sum is not large, and considered in the light of losses sustained, it appears that more money could well be expended for spraying operations. Under present conditions this would necessitate more spraying rigs and additional crews of men, with the attendant difficulty of finding profitable employment for both horses and men when their presence was not needed in the orchard. These considerations suggested the wisdom of purchasing and testing out a high-pressure outfit as one possible means of developing economy and raising the efficiency of spraying practices in New York. It was thought that with an outfit of large capacity and power not only could more acres of orchard be sprayed within a given time, but that with a great volume of spray under high pressure, more effective work could be done against such pests as fruit-puncturing capsids, pear thrips, apple aphides and perhaps the codling moth.

Because of unfamiliarity as regards the essentials for such an outfit we sought the advice of Dr. A. L. Melander and, in accordance with his specifications, we purchased a spraying machine which is capable of maintaining a pressure of 300 pounds or more and discharging a flow of spraying mixture as high as fifteen gallons per minute, with a set of four "Clipper" nozzles. The hose was in two lengths of fifty feet, furnished with extra long couplings and equipped with eight-foot brass-cored extension-rods. The outfit, when carrying a load of two hundred gallons of spray, had a weight of about 3600 to 3800 pounds, which is less than that of some machines we have used in the past.

[1] Geneva Bulletin 376, 1914.

Of the various experimental activities conducted also under the immediate supervision of one entirely familiar with the western methods of high-pressure spraying, two projects are at this time of special interest: (1) Penetration of spraying mixtures to lower calyx cavity of apples by high and low pressures, using respectively Bordeaux and Vermorel nozzles, and (2) Comparative effectiveness of high and low pressures with the foregoing two types of nozzles against the codling moth.

Penetration of Lower Calyx Cavity

In the experiments against the codling moth it was obvious at the outset, that notwithstanding what system was being followed, only a very small percentage of the young apples showed penetration to the lower calyx cavity by the liquid. In order to get further data on this point it was decided to stain the spraying mixture, which was accomplished by using ten packages of "Diamond Dye, Crimson" to about ten or fifteen gallons of the liquid. The dye was added during the course of the regular spraying operations, as demanded by the tests in a Baldwin orchard, but as soon as the colored spray was being discharged at the nozzles the operators were urged to take special pains to do thorough work, shooting as it were the spraying mixture into the throat of every blossom. Immediate examinations substantiated previous observations, but in order that closer inspections could be made, whole clusters of apples were removed from the trees and examined in the laboratory under a lens, where the condition of each fruit with respect to the penetration of the liquid was noted. The data, as finally classified, is contained in the following table:

Table I. Showing Penetration by Bordeaux and Vermorel Nozzles

Conditions of Calyx Cavity	Vermorel Nozzles		Bordeaux Nozzles	
	No.	Per cent	No.	Per cent
Apples examined	135		62	
Apples with spray in lower cavity	0		0	
Apples stained at point of contact of stamens	9	6.6	5	8.1
Apples with traces of stained pollen in lower cavity	32	23.7	12	19.4
Apples with considerable stained pollen in lower cavity	21	15.6	13	21.0
Apples with no stained pollen in lower cavity	82	60.7	37	59.7

Comparative Effectiveness of High and Low Pressure Spraying Against the Codling Moth

In view of the foregoing figures it is now of interest to note the results of spraying in this orchard with respect to the protection of the crop by the two methods of spraying. Arsenate of lead was

used in amounts varying from one to three pounds to fifty gallons of water. The strength of lime-sulphur was one gallon of concentrate testing 32–34° B. to forty gallons of water. Applications were made with pressures of 300 pounds or more with Bordeaux nozzles and about 200 pounds with Vermorel nozzles.

Table II. Showing Results from High and Low Pressure Spraying

Conditions	Sound Apples	End Wormy		Side Wormy		Total No. of Apples	Per cent Wormy
		No.	Per cent	No.	Per cent		
Vermorel 3 lbs. to 50	7603	60	0.72	645	7.76	8308	8.48
Vermorel 3 lbs. to 50	6192	45	0.67	515	7.63	6752	8.30
Bordeaux 3 lbs. to 50	7532	22	0.28	406	5.10	7960	5.38
Bordeaux 3 lbs. to 50	3376	6	0.17	229	6.34	3611	6.51
Bordeaux 1 lb. to 50	6427	71	1.02	439	6.33	6937	7.35
Bordeaux 1 lb. to 50	5079	40	0.73	340	6.23	5459	6.96
Vermorel 1 lb. to 50	5417	53	0.89	464	7.82	5934	8.71
Vermorel 1 lb. to 50	5286	111	1.92	384	6.64	5781	8.56
Bordeaux 2 lbs. to 50	7361	20	0.26	330	4.28	7711	4.54
Bordeaux 2 lbs. to 50	7710	53	0.66	307	3.80	8070	4.46
Vermorel L. S. & Lead 1–50	5880	103	1.56	601	9.13	6584	10.69
Bordeaux L. S. & Lead 1–50	8331	123	1.34	693	7.58	9147	8.92
Check	5968	318	4.45	866	12.11	7152	16.56
Check	5280	234	3.56	1055	16.06	6569	19.62

The data as presented are based only on preliminary experiments which were conducted during the past season under the efficient direction of a western expert in order to familiarize our entomological staff with the methods of high-pressure spraying; and there is no necessity for anticipating conclusions. However, it is apparent that the results, while of interest to professional workers, have a practical bearing. To follow the advice that "the spray be directed from above and be driven squarely against each blossom" in a typical apple orchard in western New York composed of trees that are high and of great expansion, would raise a lot of new problems, involving largely the surmounting of practical difficulties that would not prove easy to conquer; in fact, if the season's experience is a criterion, would stir up more hares than one would care to run down. On the other hand, if penetration of the lower calyx cavity is not really necessary under our conditions, then the needs of the orchardist can be met with a broad sweeping spray. From this standpoint a high-pressure outfit would still possess merits—rapidity of discharge and carrying power of the spray, affording possibilities for economy of time and a wide field for the development of higher standards of spraying than now generally prevail.

Mr. C. T. Brues: I am very much interested in this paper, for, as you know, somewhat similar work with high-pressure spraying has been done in the West by various entomologists. I must admit I am not quite familiar with the percentages of sound fruit which are generally obtained in the most successful work in the West. If Mr. Parrott can tell us what the percentages are I would like to know.

Mr. P. J. Parrott: By means of high-pressure spraying they have been able to grow apples in the West that run 95 to 97 per cent free from injury by codling moth. On the other hand, it is reported that by the use of Vermorel nozzles great losses to the crops are sustained. Evidently eastern and western entomologists, as far as control of the codling moth is concerned, are working under different conditions.

Mr. C. T. Brues: Dr. Melander is also of this opinion. I saw him for a few hours after his return from the experiments in New York, and I judged from what he said that the sprays failed to penetrate, at least to the extent that normally occurs in the West. Is it not possible that there is difference in the position of the floral parts?

Mr. P. J. Parrott: I believe that is the pith of the matter.

Mr. E. P. Felt: I would like to ask at what time in the development of the blossom was the spraying done—after the stamens were dry or were they still green?

Mr. P. J. Parrott: The petals had dropped and the stamens were commencing to shrivel.

Mr. E. G. Titus: How near did you get to the blossoms and did you actually drive the spray in?

Mr. P. J. Parrott: In the case of the apples, which were examined to determine the extent of the penetration of the colored spray, the nozzles were held quite close to the fruit during spraying operations. These showed no penetration, but it should be stated that in the course of the various experiments the spraying mixture was sometimes found in the lower calyx cavity. Certain it is that, under the conditions in which we were working, it was not an easy thing to force the spray through the different structures in the calyx cup of the Baldwin apple.

Mr. A. L. Quaintance: For the last two or three years the Bureau has been making a comparative study of the calyx cup in eastern and western apples and it shows that the western apple has a much more open arrangement of the stamen bars than the eastern apples, and this explains the situation. The position of the western entomologist and the position of the eastern entomologist are accounted for by the difference in the arrangement of the stamens.

Mr. P. J. Parrott: In the October number of the *American Naturalist* there is an article by Mr. W. J. Young which clearly explains

the variations in apples due to differences in environment. I hope later to add more to this phase of the question.

Mr. W. M. Scott: There is another question that Mr. Parrott's paper raises and that is the question of pressure. I think that we have been somewhat extreme on that point. The spray pump people have vied with each other to put out machines that would give the highest pressure and deliver a large quantity of material per minute. The result has been, according to my observation, injury to fruit and foliage by an excess of spraying material in the first place, and in the second place (and I think not an unimportant point either) by actual mechanical injury from driving spray under high pressure.

I have been knocking around over the country quite extensively in the last couple of years, looking into just such matters, and I frequently find apple crops injured by arsenate of lead and lime-sulphur solution. Upon making inquiry I find that most of that injury is found in orchards where high-pressure machines have been used. Professor Quaintance and I, a few years ago, conducted a coöperative experiment in the use of lime-sulphur solution and arsenate of lead in spraying apples under high pressure. I think we had 300, possibly 350, pounds pressure and on the trees that we sprayed under that pressure, the foliage was badly injured and the fruit badly burned—to the extent perhaps of 50 per cent loss of the crop. Whereas the adjacent trees sprayed with the ordinary outfit, using the mist type of nozzle, did not show the injury—or at least not very much of it.

I think that is a point we ought to bear in mind in recommending applications with high pressure machines.

Mr. E. G. Titus: In Utah it appears that 125 pounds is sufficient so far as pressure is concerned. The ordinary barrel pump will give sufficient pressure with the ordinary driving spray and will give better results than a 300-pound pressure outfit. It has been done many times. So far as penetration is concerned, we can penetrate with this pressure in a very high percentage of cases. In some recent experiments against the fruit-tree leaf roller, in which the question of the codling moth came in, I had no trouble at all with an ordinary barrel pump in getting less than one-tenth of one per cent calyx wormy, and less than five per cent side worms in the orchard, and I am certain that we did not get a hundred-pounds pressure. On another orchard we used a power pump, but didn't attempt to get over 150 pounds at any time—I do not think it is necessary. The very high pressures not only injure the apples, but they actually blow some blossoms right off the limbs.

Mr. Watkins: Perhaps you would like to know the policy of the University of Illinois. For five years we have been recommending

pressure at 125 pounds and nothing higher. This past year we have estimated that we had 1800 per cent moth, that is, 18 worms for every unsprayed apple.

In our 1914 pressure experiments similar to Mr. Parrott's, we found that a pressure of 125 pounds controlled the moth more efficiently than 250 pounds. We also found that nozzles which produced a mist spray were preferable to the Bordeaux nozzle.

Hence I believe in using and continuing to use things which we know to be effective in our own orchard. The trouble I find in our experiment station work is that growers are in the habit of taking up with any new hobby that comes along. Because Professor Melander in the State of Washington is successful in controlling the codling moth by using high pressure, it is no sign that we can have equal success with the same methods here. We can probably get good results regardless of the number of poisoned particles which lodge in the calyx cup.

Mr. A. L. Quaintance: I take the liberty to speak again to endorse the remarks made in regard to pump pressure in spraying. A good deal of evidence is accumulating which indicates that very thorough work may be done in the control of the codling moth by a much lower pressure than is currently believed. I would not be surprised that we shall find that from 125 to 150 pounds pressure, with good thorough spraying, will answer, as well as 200 or 250 pounds pressure. Coarse nozzles, of the Bordeaux type, at least under eastern conditions, do not seem to give superior results in the protection of fruit than Vermorel or Eddy Chamber nozzles, and the latter, as is well known, are much more economical of the spray liquid.

Mr. E. N. Cory: Have you had any experience with the airtight sprayers run at 175 pounds pressure on the principle of the atomizer?

Mr. Watkins: The airtight sprayers have changed this year so that it is impossible to justify any recommendations. Last year they were run by a two-cycle engine and no agitator; this year they have a four-cycle engine and an agitator. The University of Illinois spraying specialist is pretty strong for an agitator, and we did not get one there last year for the simple reason that it did not have an agitator. This year, since it is made with an agitator and the four-cycle engine, it is our intention to test it. I know of several machines that were turned back to the company last year.

President H. T. Fernald: The next paper on the program will be given by Mr. Shelford.

SUGGESTIONS AS TO THE ORIGINAL HABITAT AND DISTRIBUTION OF VARIOUS NATIVE INSECT PESTS

By V. E. Shelford, *University of Illinois*

I. Introduction.—Before Eastern North America was put under agricultural conditions it was densely covered with forest west to the Illinois and Mississippi Rivers, and with conifers to the north, Fig. 10. Along the western border of the forest was a belt of prairie or savanna which consisted of groves of forest, stream skirting forest, interspersed with moist grassland. To the west of this were the arid plains along the rivers of which was moist area vegetation. Considering the forested portion of this we cannot too much emphasize the fact that it was continuous forest entirely different from the present open aspect. The forest was broken in the eastern portion by rivers and marshes and sand dunes of the lakes and coast, which formed an insignificant portion of the entire area. In addition to this there were small "islands" of moist prairie scattered eastward north of the Ohio River as far as central Ohio.

Scarcely any of the pests of forage or garden crops are forest animals, and only a few orchard and small fruit pests are strictly so. When we consider that these pests have made their way in Eastern North America at least, on to planted crops where ever and as fast as these have been put out, we must explain their presence either by assuming a rapid migration with the development of agriculture and the clearing of the land, or we must assume that these animals were present through-out the forest area before agriculture was introduced. While some species have migrated beyond doubt, others have in all probability notd one so.

II. The Original Habitat of Native Pests.—A close study of the habitat preference of various insects appears to throw much light upon the original habitat of a great many native pests. Taking first the insects which frequent garden and forage crops and which are widely distributed, an inquiry into their habitat shows that they fall into two classes, (*a*) those frequenting low moist situations, and (*b*) those preferring higher and drier ground. An examination of the fragments of primeval vegetation likely to support such insects shows that the moister situation frequenting species are found along the margins of ponds, (Pl. 7, fig. 1), lakes, rivers and even on the vegetation growing in the water, and on marsh meadows or grassy areas covered by water in spring but dry in summer.

Taking Sanderson's recent work on insect pests and Forbes' report on the insects of the Indian corn plant and comparing them with lists

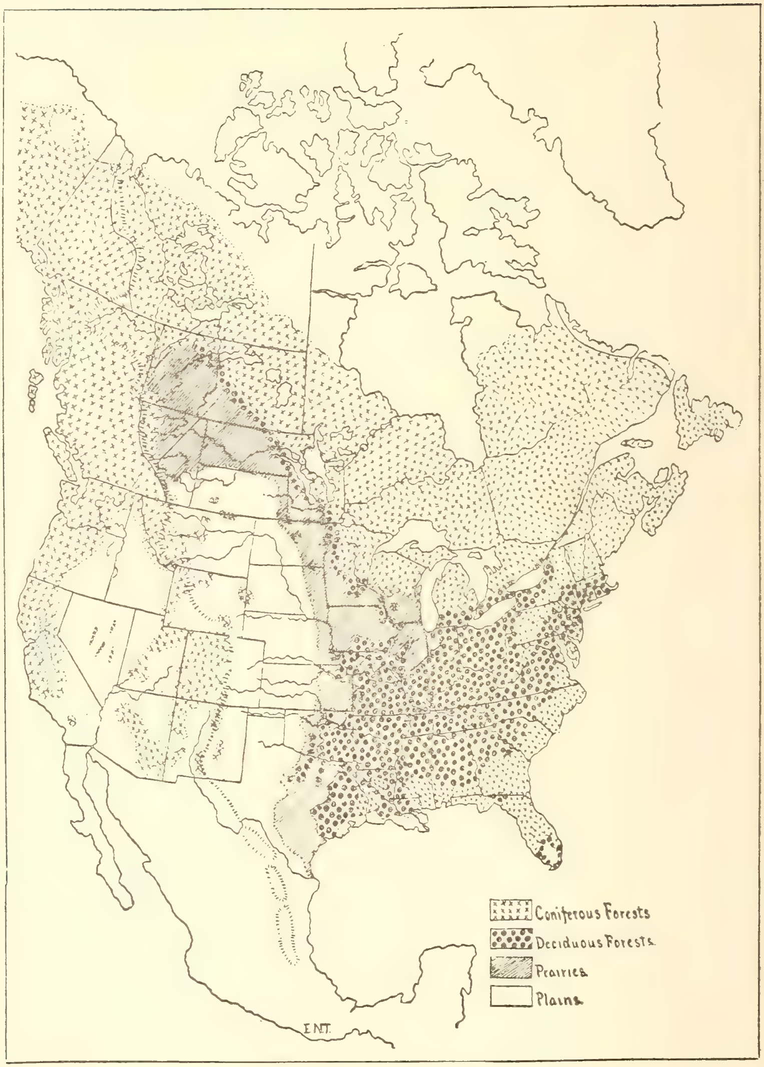

Figure 10—Showing the distribution of vegetation in North America before it was put under agricultural conditions. The shaded "prairie" area may be regarded as the original center of abundance of agricultural pest species.

of species taken by the writer on the margins of ponds and lakes such as are shown in Plate 7, figure 1, we find that one third of the phytophaga listed are mentioned by one or both of these authors. A comparison of lists of species taken from the margins of sandy depressions such as occur about the lakes and larger rivers and we find again roughly one-third of the species mentioned by one or both of these authors.

In the forest area lakes and ponds formed by glaciation and the "oxbows" by rivers often filled with vegetable detritus and become covered over with a low wet meadow, a part of which may be under water in spring. Such situations were originally common throughout the eastern portion of the United States, particularly where glaciation has taken place, but are by no means wanting in other localities. These moist meadows nearly always were surrounded by forest and the boundaries between them were forest edges. A forest edge is a thicket made up of rank weeds on the side nearest the meadow; inside of these are various shrubs arranged in belts and increasing in height as we go toward the forest. Considering the marsh meadows and associated forest edges we find on comparing lists of species collected from these situations with the works mentioned above, that more than one-half of the phytophagus species are mentioned as important.

Turning to the species which frequent the higher and drier ground and which are found under the same conditions as crop pests, we find that the steep lake (Pl. 7, fig. 2) and river bluffs, the bare rocks exposures upon which trees do not grow, support numbers of them. The bare steep bluffs are the haunts of the dry bare ground frequenting forms like *Dissosteira carolina* and the vegetation supports aphids, locustids, and beetles of great economic importance.

The forest encroaches upon these situations as a shrub thicket similar to the moist forest edge. These shrubby thickets are made up of hawthorn, wild plum, with occasional cherry, gooseberry, cottonwood, willow, etc. These are the headquarters of the pests of small fruits, apples, etc., and preëminently the headquarters of the orchard birds. These shrubby thickets of the river banks, etc., are duplicated on the flood plain itself where hawthorn, grape, currant grow either in open scattered formation or in dense thickets. These thickets support the majority of our native pests of the fruit-bearing trees and shrubs.

III. The Original Distribution of Native Pests.—Considering the distribution of the marsh and moist vegetation inhabiting species, we find that on the whole it is exceptionally wide, and similar to the distribution of the marshes themselves, and within wide range of climatic conditions represented by the greater part of the United States and Southern Canada (except the arid southwest) and a northward extension in the plains and prairie region of western Canada (Fig. 10). Some of the species common in the swamps of New England may be found on the prairies at Edmonton and the grassy marshes of the lower Mississippi and along the irrigation ditches of the Rio Grande in New Mexico.

The species occupying the higher drier bare ground, and scattered

vegetation growing upon it were not distributed essentially differently from the above, but were near to water in the more arid climates.

The native pests of our fruit-bearing shrubs and trees were originally less widely distributed than the others because the thickets which supported them were less widely distributed, being confined more generally to the deciduous forest area (Fig. 10) and the savanna or moist prairie area.

IV. Center of Abundance of Native Pest Species.—We cannot too strongly emphasize the unbroken character of the original forest of the area shown as forested in the map (Fig. 10). Accordingly the pest species referred to above were crowded into the cracks of the forest and scattered along the river margins of the great plains. The area shown as prairie in figure 10 is made up of moist grass land, river skirting forest with groves away from the rivers making the forest edge or thicket of hawthorn and plum a very important habitat in this region. With the extensive moist grass land areas mixed with this, the space available for pest species was great. We may consider the original center of distribution and abundance of native pests as lying within the area of "prairie" or savanna shown in figure 10.

V. The Expansion of Local Range of Pest Species under Agricultural Conditions.—With the clearing of the land and the putting out of crops in the forest area, the habitats of the pests in the cracks and corners in the forest was expanded to cover the agricultural lands as far as they were cleared. With the building of roads the roadside ditch, roadside thicket and the road itself made a complex supporting all of the various types we have mentioned (Fig. 3). Thus the local species of primeval conditions took on a general distribution under agricultural conditions.

Explanation of Plate 7

1. A pond margin; a type of situation of very wide distribution in North America—one-third of the phytophagus insects taken here are mentioned by Forbes and Sanderson.
2. Dry clay bluff supporting such forms as *Dissosteira carolina* and the vegetation of which supports the Xiphidiums, aphids, and plant bugs common on crops grown on high dry ground.
3. A roadside habitat combining most of those mentioned in the paper as normal to primeval conditions.

President H. T. Fernald: The next paper on the program will be by Mr. E. G. Titus. He will speak on "A Clean Town Contest."

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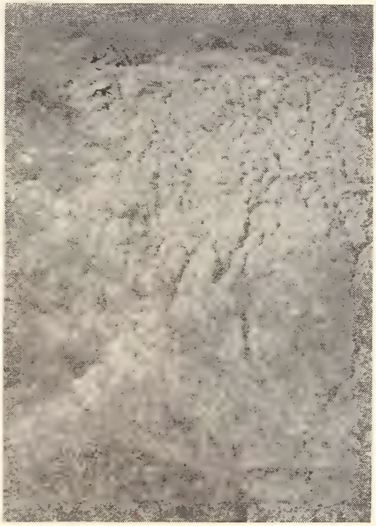

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A CLEAN TOWN CONTEST

By E. G. Titus, *Logan, Utah*

This movement has been carried on to some extent in other states and has been supported by mayors, officials, boards of health, and so on, but we intended it to be a state contest. A year ago we started work upon this Utah contest and on the first of June, 1914, we had fifty-six towns entering the contest. These were divided according to population, Salt Lake and Ogden being of course the largest. In the next class, 3,500 to 9,000 towns, three out of the four in the state entered. The next class 2,500 to 3,500, seven towns entered out of eleven in the state; in the next class, 1,500 to 2,500, ten towns out of sixteen entered; Class "E," 750 to 1,500, eleven out of twenty-eight entered; and in Class "F," towns under 750, there were fifteen out of thirty-eight that could have entered the contest. We had a fairly representative number of towns in the state entered. A number of prizes were offered by the Utah Development League. In a number of towns that went through the competition there were also side prizes for better lawns, best appearing lots, best flower gardens, best equipped places in the business section of the town, etc.

The following are the final scores of the towns entered and scored:

Class "A": Cities of 25,000 and over.

Ogden	73
Salt Lake	70

Class "B": Towns of 3,500 to 9,000 population.

Brigham	70.6
Provo	64.6
Murray	46.5

Class "C": Towns of 2,500 to 3,500 population.

Lehi	71.7
Spanish Fork	62.5
Springville	61.8
Richfield	59
Park City	59
American Fork	55.5
Nephi	41

Class "D": Towns of 1,500 to 2,500 population.

Manti	82.5
St. George	70.5
Beaver	70
Smithfield	69.3
Cedar City	65.0
Richmond	52
Pleasant Grove	51
Ephraim	43
Bountiful	40
Payson	35.1

Class "E": Towns of 750 to 1,500 population.

Farmington	67.5
Fairview	67
Parowan	62
Kaysville	59
Panguitch	57
Sandy	54.4
Coalville	52
Fillmore	50
Providence	48.3
Salina	43
Morgan	42

Class "F": Towns under 750 population.

Hurricane	78
Mapleton	66.8
Millville	56.1
Levan	54
Salem	54.6
Mayfield	52
West Bountiful	52
Minersville	52
Washington	48
Randolph	48
Tremonton	45.3
Scipio	45
Alpine	50.5
Garland	29.3
Kamas	39

The following notice gives the system of scoring:

INSPECTION

Inspection of the towns will begin August 17th and continue until all entering the contest have been inspected and scored. No information will be given as to date when inspection will be made. All towns must be ready for inspection.

Towns Will be Scored on the Following Points

Basis 100

	Points
1—Sewage: Disposal of—privies, cesspools, etc.	15
2—Stables and corrals, disposal of manure, etc.	15
3—Garbage, collection and disposal	10
4—Water supply	10
5—Sanitation of school houses and other public buildings	5
6—Sanitary marketing of foods	5
7—Presence of flies	5
8—Sanitation of the home, cleanliness of the home, ventilation, etc.	5
9—Condition of streets, parks and alleys	10
10—General appearance of homes, barns, barnyards	5
11—Lawns and flower gardens	5
12—Vacant lots	5
13—Fences	5
Total	100

The State Board of Health had charge of the inspection of the towns and the whole competition was carried out in a most friendly spirit. Its developments were remarkable, if only purely in advertising for the state, and this is incidentally one good means of advertising.

Mr. C. Gordon Hewitt: We are all aware of the great importance of movements of this kind, and I believe every one of the members here has listened with much pleasure to Professor Titus' account. One of the things that has particularly impressed me, as shown by that small diagram of a section of a town, is the enormous amount of work which has been involved in making a survey of this kind. If Professor Titus' paper has shown us nothing else, it has demonstrated that the entomologist is something more than a man who goes around recommending "how to squirt trees"—but a man who is becoming more and more intimately concerned with the life of the people. We heard last year in our meeting at Atlanta a paper by Professor Hinds in connection with boll weevil work in the south, how the entomologist was becoming more and more concerned with the life of the people and with their economic conditions which are not entirely "entomological." I think this paper by Professor Titus shows the entomologist to be something more than a person who simply destroys insects, and that he is becoming more and more vitally concerned with economic studies and with the movement for improved conditions of life for people generally.

Mr. R. A. Cooley: I would like to ask the amount of expense involved in conducting this campaign?

Mr. E. G. Titus: From the standpoint of the town I am unable to state, not having the figures. We are attempting to gather them and hope to have them tabulated some time this winter. In case of the Utah Development League, the chief expense possibly was the clerical help and the printing of circular letters of the type I have sent around for examination; for a circular of this kind (indicating), another one of this kind (indicating), and all showing the *Clean Town* policy and scheme. And the money expense was defrayed from the expenses of the Utah Development League as part of the advertising campaign. The largest expense was judging the towns. I have not the judges' expense accounts, but I can figure on judging thirteen of the towns, in classes "B" and "C," and I think the judging occupied from two to four days to a town. In class "C," most of the towns could be judged in from one and a half to two days, and in class "B" three days. It would not average over twenty-five dollars a town except for class "A." Of course for the larger towns it cost more and in the smaller town it

dropped down perhaps to four or five dollars. Then there were some more inaccessible. For instance, there was one town one hundred and fifty miles from a railroad, took two days on a stage, and then a day and a half to get to the town with a rig after that, away back in the mountains. There were several towns located in this way and the judging expense of course was high. Some of the towns offered to defray part of the expense in order to be sure that the judge came down and visited them. Perhaps the little town of Manti cost the most to the town since the town offered a large number of prizes and they went into it rather heavily. The interest was so strong that when the judging was postponed for several days, they received word by telephone, and they had a man out in an automobile the next morning with a megaphone announcing that they had "three more days to clean up" and "to get busy." And they did get busy.

So far as the expense is concerned, it is really small, I believe, compared with the benefit the town received from it. Even real estate men were interested and some told me that the increase in the value of real estate was worth many times the cost it had been to the town or state.

A Member: The expense then was borne by the Development League?

Mr. E. G. Titus: Yes, and also the State Board of Health, and others, and then we brought in one man from outside to judge Salt Lake and Ogden. There was considerable rivalry between the two cities—they are close together.

A Member: I want to express my appreciation and hearty approval of this line of work. I know something about such work and judge that it must have taken an enormous amount of energy and labor to carry this contest to a conclusion.

Mr. E. G. Titus: Larvacides were used to a very slight extent; the main thing was to get manure out of the way. In some of the towns we did try out borax and other things. We had some manure containers or large vats built in the state; we built one at the college and I believe there have recently been others built at different times. They suit us pretty well.

Mr. F. C. Bishopp: I am sure Dr. Titus is to be congratulated on the admirable way in which this campaign was conducted. I was much pleased with the results secured in the small towns. From the little we have been doing in the south, we have seen that that is going to be the big problem—large cities will take care of it better. I was very much pleased indeed to see how the small towns showed up in this contest. I wanted also to mention a point that he briefly brought out, that is, the need of caring for breeding-places in the winter time.

In the course of the Texas work the importance of getting rid of the breeding-places in the winter time seems to me to be very great. We have found that by a thorough cleaning-up in the winter we could do very much more than we could by continuing the work during the summer only.

Mr. E. P. Felt: How about disposal of manure containing over-wintering pupæ?

Mr. E. G. Titus: Manure has been carried some distance from the town and we have fairly good assurance that the flies will not come back in the spring. We found some that would go through the winter in the pupal state and these appear to be destroyed when the manure is properly scattered. Where possible the manure is taken out and scattered in fields and we found we could accomplish fairly complete destruction. In other cases, the manure was piled in ricks in the field.

Mr. E. P. Felt: Does that hold true in the north where they are frozen up?

Mr. E. G. Titus: I couldn't say, but I think that by breaking up the manure and scattering it over the ground you will destroy many of the puparia. We found them hibernating in piles against barns and other protected places, and by cleaning those out you can greatly aid the matter.

Mr. E. N. Cory: I would like to have your opinion of the distance that flies will travel.

Mr. E. G. Titus: We marked somewhere between seven thousand and eight thousand flies the last few years and then hunted for them afterward. We found a few of them but I found no flies at any time a half a mile away from the place where they were liberated.

In Salt Lake City, Utah, there was complaint that flies were coming from the city dumping-ground. You remember our Salt Lake blocks are large and four of them would make a pretty good-sized distance to walk. In the country we found the same thing, where we took them out into the farm region and liberated them in the pastures, and under those conditions we never found any that would reach beyond half a mile. Now perhaps our conditions are different; the dry air may have something to do with it, and I would like to hear if anyone has done anything on that line. It is quite essential on our end of the work on the fly.

Mr. T. J. Headlee: Mr. C. H. Richardson of our department carried on some flight experiments during the past season. Flies marked in various ways were liberated at a distance of 1,715 feet from the pig barn on the college farm at New Brunswick. About three thousand individuals were liberated at a time in one place and in most of the trials from ten to fifteen marked flies were recovered in the traps at the pig barn.

Mr. C. Gordon Hewitt: As Professor Titus has raised the question of the flight of the house-fly, I should like to give my own experience in the matter; as important results were published in a report by the British Local Government Board, on the carriage of infection by flies. Two or three years ago I had some experiments carried out in the city of Ottawa to study the flight of flies under city conditions. Flies were bred out and then marked with rosalic acid. They were liberated at a given point in a fairly well-inhabited region, throughout which Tanglefoot papers were distributed in the houses. These Tanglefoot papers were collected from day to day. Out of the 13,500 flies that were liberated, 172 marked flies were recovered at varying distances from the point of liberation, the farthest being 700 yards. In a further report of the British Local Government Board, experiments carried out by Copeman, Howlett and Merriman in Norfolk, England, demonstrated that under rural conditions flies travel from three hundred to seventeen hundred yards from the refuse in which they are bred; their flight depending largely on the prevailing winds. Experiments are recorded by Nuttall, Merriman and Hindle who carried on experiments under urban conditions in Cambridge, England, which bear out on the whole the limited range of flight of flies under city conditions. I think those interested would do well to consult these reports, which I think could be easily obtained.

President H. T. Fernald: The next paper will be read by Glenn W. Herrick.

ADDITIONAL DATA CONCERNING THE CONTROL OF THE FRUIT-TREE LEAF-ROLLER IN NEW YORK

By Glenn W. Herrick

During the past three years the fruit-tree leaf-roller, *Archips argyrospila*, has been exceedingly abundant in parts of New York State and has caused serious losses to fruit-growers. In the spring of 1912 an extensive series of experiments in an orchard in Genesee County was conducted in an attempt to control the leaf-roller by destroying the larvæ with poison and contact sprays. In all, over seventeen combinations of materials were tried on different groups of trees in the orchard. Most of the applications were made before the cluster of flower buds had separated. At this time, however, a large part of the eggs had hatched and many larvæ had already worked their way down among the cluster buds and were feeding on the buds and bud stems.

The results of the whole series of experiments were really very discouraging so far as prevention of injury to the fruit was concerned.

There was so little difference between the sprayed and unsprayed portions that it did not seem worth while to make a count of the fruit. The orchard produced only about two hundred and fifty barrels of apples out of a normal eight hundred barrels and these were mostly in the tops of the trees and in portions of the orchard not so badly infested. In this connection, the work of one of the better and more intelligent fruit-growers in New York is of interest.

The large orchards in question were sprayed five times and sprayed thoroughly and intelligently. The orchards were sprayed first, in the dormant condition, just before the buds burst, with lime-sulphur, 1 gallon to $6\frac{1}{2}$ gallons of water with 1 pint of black-leaf-40 to every 100 gallons for the aphis. The second spraying was made just before the blossoms opened with lime-sulphur 1 to 50 and 3 pounds of arsenate of lead. The third application was made just as the petals had fallen and consisted of lime-sulphur 1 to 50, arsenate of lead 3 pounds and black-leaf-40, $\frac{3}{4}$ pint to 100 gallons. A fourth spraying was made about 10 days to two weeks after the third with lime-sulphur 1 to 50 and 3 pounds of arsenate of lead. At about this time the owners became much worried about the roller and sprayed a fifth time with arsenate of lead alone, 4 pounds to 50 gallons. In spite of this extraordinary amount of careful and thorough spraying, the trees and cover crop under the trees were alive with larvæ and 40 per cent of the crop was ruined.

Gillette and Weldon performed a series of experiments in Colorado in 1912 in an attempt to control the leaf-roller by the use of poison sprays.[1] The first spray was applied May 5. The cluster buds had separated but the buds had not begun to open up. At this time "practically every blossom bud picked had from three to five larvæ feeding in it." They estimated that 75 per cent of the larvæ were killed by this and succeeding applications. Unfortunately 25 per cent, where the larvæ are multitudinous, is quite sufficient to cause disastrous results. The question, of course, arises as to whether the remaining 25 per cent can be caught before they enter the buds or get out of the way of the poison. Mr. J. B. Gill, in his thorough work in New Mexico and Canon City, Colo., found that "applications of arsenicals alone and in combination with 40 per cent nicotine solution have greatly reduced the amount of injury to the fruit and foliage, but these sprays have not been so effective as desirable." On account of the long period of egg-hatching it is almost impossible to poison the larvæ before they become safely hidden. Especially is this true in case of late varieties of apples.

[1] 1912, Circular 5, Colorado Experiment Station.

In conclusion of this brief consideration of the poison sprays it should be said that in every case much benefit was derived from them in protecting the foliage and enabling the trees to develop fruit buds for the subsequent season. Nor is this to be considered of little moment or of slight importance. At the same time, fruit buds are of little value if they are so eaten by insects that they cannot develop into fruit.

Experiments with Miscible Oils to Destroy the Eggs

In the spring of 1913 we planned and carried out a series of experiments in a badly infested orchard with the miscible oils, using Scalecide and the Orchard brand manufactured by the Thompson Chemical Company. In all, thirty large russet trees were included in the experiment and carefully sprayed with the oils at the proportions of 1 to 15. In addition to these trees included in the actual experiment many more were sprayed by the owner with Scalecide at the rate of 1 gallon to 15 gallons of water.

The oils were applied April 2 and 3, of course, before the buds had started, although they had begun to swell. Unfortunately, it rained hard in the afternoon of April 3 and the oil applied that morning had been on only four hours, while the oil applied the day before only about twenty-four hours. Undoubtedly this influenced the final results.

On May 13, I made a rather extensive and tedious count of the eggs killed by the oil in different masses. In the experimental rows the masses were taken mostly from the row that was sprayed in the forenoon of the day on which it rained in the afternoon. We were not aware of this until we consulted our notes later. The results of the count showed that a fraction over 76 per cent of the eggs had been destroyed and did not hatch. In that part of the orchard sprayed by the owner a more extensive count of egg masses showed that practically 79 per cent of the eggs had been killed.

The general effect of the spraying with the miscible oils was better than we hardly dared hope. In the first place, there is no appearance in the orchard of injury caused by the oils. We were careful to make the applications just as near the active growing period of the trees as possible. Moreover, the spraying was done in moderately warm weather. The orchard bore a fair crop of fruit and the owner is much encouraged.

Gill, in his work in Colorado with the miscible oils killed a much higher percentage of the eggs. Gillette and Weldon in Colorado succeeded in killing 95 per cent of the eggs. From their accounts it appears that the trees were more thoroughly drenched than were the

trees we sprayed in the New York orchard. If it had not been for the fact that we feared the effect of the miscible oil sprays we should have insisted on a more thorough drenching.

Again, in 1914, a still more extensive series of experiments based on knowledge gained in the previous seasons was planned and carried out in coöperation with two growers at Hilton, N. Y. Mr. R. W. Leiby was placed in charge of these field experiments and to his thorough and careful work we are greatly indebted for our results.

Briefly, three brands of miscible oils were used in a preliminary way on small areas in which the results could be accurately checked by careful counts of eggs, hatched and unhatched. In cage experiments carried out indoors Target brand killed 94.7 per cent of the eggs while Scalecide killed 96.2 per cent. In the check, 95.75 per cent of the eggs hatched.

In outdoor experiments confined to a few plum trees on which the egg masses were located and marked by tying strips of white cloth about the branches, Target brand at 1 to 20 killed 92.6 per cent of the eggs, Scalecide, at 1 to 15 killed 91.2 per cent and Orchard brand 87.4 per cent. The average for the three oils was 90.4 per cent. Very likely these egg masses being so conspicuously marked were more thoroughly treated than would be the case in ordinary orchard spraying. The results in the main orchard would indicate this.

In the main orchard, sprayed by the owner in the ordinary way, yet thoroughly, an extended count of egg masses showed that an average of 85+ per cent of the eggs were destroyed. In general orchard spraying it is an exceedingly difficult matter to hit all of the egg masses or to thoroughly wet all that are touched with the mixture. It is doubtful if the average grower will be able to kill over 85 per cent of the eggs on large apple trees for the simple reason that some of the masses will not be actually hit with the liquid. If, on the average, 85 per cent of the eggs can be destroyed with the miscible oils they will constitute a most efficient check against serious infestations of the leaf-roller.

We did not, however, rely on the miscible oils for the complete control of this insect in the orchards under consideration. We planned to supplement the oils with arsenate of lead and on May 7, the next day after the eggs began to hatch, the orchards were sprayed with the poison at the rate of 3 pounds to 50 gallons of water. The buds had just begun to burst and two or three leaves had separated.

A second application of lead in the same proportions was made on May 14 just before the blossom buds had separated. Finally on May 26 the first codling moth spray was applied. The results were very satisfactory and the owners feel that they can control the leaf-roller.

Their feeling of great discouragement produced by the conditions in 1913 has changed to a hopeful and confident assurance that the problem has been solved.

In some field experiments which cannot be detailed here we were unable to control the leaf-roller to any degree of satisfaction by omitting the application of oils.

Finally, in our treatment of hundreds of apple, pear, plum, and cherry trees not a single case of injury has been found from the effects of the oils. In addition, many barrels of oil were applied last spring throughout western New York and so far as we have personally examined the treated orchards or have been able to talk with the owners of treated orchards we have not found any injury. It should be noted, however, that the oils were applied in the spring and only after the trees had become more or less active or very near the time of the beginning of activity. Moreover, we were afraid of the oils and constantly warned the owner in his general orchard spraying to be careful and not drench the trees. Had the oils been applied more liberally and had the trees been more thoroughly drenched, probably a higher per cent of eggs would have been killed. The owner declares that next year he is going to apply the oils at the rate of 1–12 and that he is going to soak his trees. We have assured him that he will do so on his own responsibility. Undoubtedly Dr. Felt has given us abundant proof that these oils do, under certain conditions, produce an injurious effect. Unfortunately, we do not know just what those conditions are.

To sum up then, our experiments seem to show that the leaf-roller can be satisfactorily controlled by an application of miscible oil to destroy the eggs, supplemented by thorough sprayings with arsenate of lead.

Mr. E. P. Felt: I am very glad to have this data, and particularly that in relation to the miscible oils, because the results as noted by Professor Herrick agree quite closely with what I think those oils will do when we make careful application.

Mr. W. W. Yothers: This subject has been quite thoroughly worked out in Florida during the past five years. The results in Florida show that the injury which follows the use of several miscible oils can be attributed to the chemicals which these insecticides contain and not to the oil itself. Dr. A. W. Morrill found that Orchard brand was very injurious to citrus trees. The present investigation experimented with this insecticide extensively and found independently that it was exceedingly injurious and that it could not be used on citrus at any time of the year. The Bureau of Chemistry analyzed this

insecticide and found that it contained $2\frac{1}{2}$ per cent of sulphuric acid and I inferred that this chemical was the cause of the injury. I regret to state that I found it impossible to introduce sulphuric acid in any of the formula with which I experimented and therefore I was not able to test any formula with and without sulphuric acid.

In regard to Scalecide, it is not so injurious to citrus fruits as Orchard brand but it does so much damage to young fruits that it is inadvisable to use it at any time of the year. The Bureau of Chemistry found that this insecticide contained much rosin or rosin oil. In other experiments with the use of rosin and rosin oil, in every instance the same formula made up with rosin oil caused much damage while the same formula with rosin oil omitted was absolutely harmless. I have concluded that an insecticide for use on citrus trees should not contain rosin oil.

Target brand is fairly efficient. It contains quite a large percentage of phenol which my experiments show is worthless as an insecticide and is more or less injurious to the trees and the fruits. It is much less injurious than either of the former articles and is used quite extensively throughout the state.

Schnarr's Insecticide is also a proprietary article and does not contain any of the above injurious chemicals and as a general proposition it does no injury to fruit or trees. Neither does the Government formula which contains none of these chemicals cause any damage to the trees or fruits if used conservatively. Thousands of gallons of these paraffin oil emulsions have been used with little or no damage.

It is my contention that if oils containing these injurious chemicals cause injury to citrus then there is also great liability that they will cause injury to deciduous trees. I think it would be a matter worth while to experiment with some of the cheap paraffin oil emulsions on deciduous trees to determine if any injury or liability to injury would follow their use. I suppose it is generally understood that miscible oils can be made from cheap lubricating oils which can be found almost everywhere and cost about fifteen cents a gallon in barrel lots.

Mr. E. G. Titus: Only in the last three years have we had any damage from this particular insect. At the present time, it has seriously infested some of the fruit orchards in two of our valleys.

This year I carried on some spraying experiments and my results are not as good as I expected them to be.

The leaf-roller injures from 50 to 60 per cent; this injury was reduced to 24, 11 and 7 per cent, roughly speaking, but even 7 per cent injury is too great to allow the leaf-roller and we wish to improve. If

anyone has been successful with miscible oils and not injured trees, I would like to hear from them.

Mr. C. P. Gillette: I am very much interested in the paper just read, because the results seem almost identical with those we had in Colorado, especially with the arsenical sprays. We came to the conclusion that it was almost useless to expect the ordinary fruit-grower to control the leaf-roller by means of arsenical sprays. It is necessary to make so many applications in order to keep the young leaves well covered with poison that we seldom find the grower thorough enough to get good results. For that reason, in the Canon City district, where the insect had become very destructive, we insisted upon the use of the oil sprays. We used "Target brand" almost entirely, and got excellent results. Where the growers failed, it was because the orchards were not well treated with the oil.

Vice-President Glenn W. Herrick: Aren't your trees generally smaller than ours in New York State?

Mr. C. P. Gillette: I think not. We sometimes gather 40 or 45 bushels of apples from one tree. I believe in Colorado, we have one advantage over the east and the south in our dry climate; it is nearly always bright and clear so that the oil evaporates quickly. In a moist climate the danger of injury from the use of oils is probably greater.

President H. T. Fernald: The next paper on the program will be by E. N. Cory.

PRELIMINARY REPORT ON THE WOOLLY APHIS[1]

By E. N. Cory, *College Park, Md.*

The results herein set forth, as the title indicates, are wholly preliminary. To the author they are in no sense conclusive, but the facts seem to warrant the belief that other experiments along similar lines may lead to a method for the control of the woolly aphis.

Because the nursery injury was the most apparent, the control of this pest was confined for a time, chiefly to nursery stock. This experimentation was begun in 1908, and has been continued as time and circumstances allowed.

This work has never been pursued thoroughly and continuously to a definite conclusion because other, apparently more important, work has always intervened. For the most part we have been content

[1] *Schizoneura lanigera* Hausm.

to advise the use of the remedial measures generally recommended. Two main lines of work have been followed, treatment of the soil with dust applications and spraying the tops and soil about the roots. Tobacco dust of various manufacturing companies and kerosene emulsion have been the principal insecticides used. In addition, apterite (a carbolic fertilizer), nicotine sulphate, fish oil soap and lime-sulphur have been used. The usual mode of application in nurseries has been to bar plow along each side of the row, apply the dust or spray and then throw the earth back around the trees.

Thus far we have been unable to secure good results with any of the above-mentioned insecticides. Kerosene has given better results than any other insecticide. However, as this paper is concerned chiefly with results achieved in orchard work, the details of our experiments on nursery stock will be left for another time.

Treatment of Orchard Trees

As in the nursery work the control experiments on woolly aphis in orchards have been in progress for several years, without determinate results.

In the spring of 1912 work was begun in the orchard of E. W. Hungerford, Marshall Hall, Md., in testing the value of various insecticides. This orchard was selected because, first: it was badly infested with woolly aphis and second because the soil in which it is set is a sandy loam. As the soil in the college orchards is a clay loam, the sandy soil conditions gave an opportunity for some comparisons.

Eleven insecticides in the form of dust or liquids were applied in trenches dug about the base of the trees. These trenches were dug down deep enough to expose the main roots and about six feet in diameter. All trees treated were infested with root aphis.

Soluble oil, 1 to 15; Scalecide, 1 to 15; Electro Insecticide Soap, 1 pound to 4 gallons of water; Lemon oil, 1 to 24; Nico-Sul, 1 to 240; lime-sulphur, 1 to 9; undiluted Pine Tar Creosote at the rate of $1\frac{1}{2}$, 2 and 3 quarts per tree, kerosene emulsion, 10 per cent; tobacco dust, $1\frac{1}{2}$ to 3 pounds per tree; One for All, $\frac{1}{2}$ pound to 1 gallon and Apterite 1 pound 3 ounces, 2 pounds 6 ounces and 4 pounds 12 ounces per tree. As this was a private orchard, it was not considered advisable to apply each insecticide to more than a few trees on account of the danger of injury to the trees. It was planned to continue the applications that held the most promise in the college orchards.

The applications were made June 24 and 25, 1912. During the night of the 24th rain fell and intermittently during the 25th so that the conditions were exceptionally favorable for complete penetration.

The trees were examined in the fall of 1912, without disclosing any

apparent injury. On April 18, 1913, the soil was removed from the base of the trees and a careful examination made for the presence of aphids with the following results: Aphids were found abundant on the roots of all of the treated trees except on two trees treated with tobacco dust at the rate of three pounds per tree; on one tree treated with tobacco dust one and one-half pounds per tree; on one tree treated with lemon oil; on one tree treated with Scalecide and on three trees treated with Electro Pine Tar Creosote. The probable effect of the last three solutions on the life of the tree was a matter of speculation, hence only a very few trees were treated. Only one tree was treated with each dosage of creosote.

The tests of the efficiency of the Pine Tar Creosote were continued in this orchard on other trees with ample checks. This was the only insecticide continued because, due to the circumstances detailed below, it was considered to hold the greatest promise. These tests will be discussed in a later paragraph.

During the examination it was found that a small ant was caring for the aphids quite as assiduously as they do for their young. Wherever aphids were found ants were present and they were not present in any case where the aphids had apparently been controlled.

Upon the removal of the earth from the base of the trees, an ant would seize the nearest aphid in its mandibles and immediately seek the shelter of the nearest clod or would follow the channels made in the soil by the roots to what it evidently considered a safe place, then it would hurry back for another aphid and repeat the process. This relationship was found to exist in every case where aphids were present.

Specimens of the ants were collected and sent to Dr. W. M. Wheeler, who very kindly determined them as *Lasius* (*Acanthomyops*) *interjectus* Mayr., supplementing the determination with the following interesting comments:

"This ant is a subterranean species which makes a business, like our other species of Acanthomyops, of dealing exclusively with root aphids and coccids. I have always supposed that these ants did considerable harm, because they go into this business quite extensively not only on the root of fruit trees, but also on the root of forest trees and even herbaceous plants. The workers of all the species of Acanthomyops have the curious odor which you noticed and described so well."

The relationship was so marked that the possibility of controlling the root form of the aphid by control of the ants in this orchard seemed worthy of a test. In other orchards the writer had previously noticed in searching for aphids, the peculiar odor, similiar to that of citronella, that is always associated with *L. interjectus*. Work was therefore

planned to ascertain the extent to which the ant was present as a symbiote in other orchards, particularly those set in heavier soils than that at Marshall Hall.

A large percentage of the trees in several of the college orchards have been examined for the presence of the ants. With great uniformity the trees examined showed the presence of *L. interjectus* accompanying aphids. Examinations were begun April, 1913, and continued throughout that season.

With these facts before the writer in regard to the ants and negative results from the tests at Marshall Hall and tests applied in July, 1912, in the college orchards, details of which will be given later, plans were laid for more thorough tests of the Pine Tar Creosote. A row of trees in the Marshall Hall orchard was selected and examined for aphis and ants. Both were found in numbers on every tree. Every alternate tree to the number of seven were treated with one quart of Pine Tar Creosote after the earth had been removed. Following treatment, the earth was replaced. This test was applied on April 26, 1913. Seven untreated trees were left in the row as checks. These tests were examined December 3, 1914, and they showed very encouraging results. The odor of the creosote was decidedly apparent even after twenty-one months had elapsed. Aphids were present on all of the checks except on two and no aphids were present on any of the treated trees except in one case. Ants were not present at the above date. This was to be expected owing to the late date of the observations. A note made in 1912 seems to indicate a congregating habit of the hibernating ants. During the early spring a cluster of *L. interjectus* was discovered in the cavity of an old tree. This was prior to our observation of the association of the ants with the woolly aphis, hence, no effort was made to keep notes on the cluster of ants. However this nest was just within the border of a wood that adjoins one of the college orchards wherein ants and aphis have since been found in abundance.

Thus far only the tests with undiluted Pine Tar Creosote have been mentioned. No injury to the roots or trees has been observed resulting from its use. The material is rather expensive—30 cents per gallon in quantity, hence tests were made of the material in emulsion. This was made by using two-thirds of a pound caustic soda, 90 per cent ($NaOH$) for each gallon of creosote. A 6 per cent emulsion was used in the college orchard in July, 1913. Eleven trees were treated in a small orchard consisting of trees grafted on American, Paradise and Doucin stocks. The trees on Paradise stock were only slightly infested with aphids, while those on the other two kinds of stocks were heavily infested. Only a few ants were present. The test was

conducted primarily to ascertain whether the 6 per cent emulsion would kill the greatest part of the aphids, and to determine the effect of the insectide on the vegetative state of the tree. Ample infested checks were retained.

Examination July, 1914, showed that while only two trees were entirely free from aphis, the balance with the exception of two trees were free from aphis where the spray influence must have been greatest, *i. e.*, near the crown. The other trees showed one or two isolated clusters of aphids far out from the base of the trees.

The application was repeated two days after the above examination and in addition eight other trees in this block were similarly treated, leaving two trees as checks.

In addition to the effect on the aphids, a most excellent effect on the vegetative state of the trees was apparent. New roots were very numerous and the old bark was replaced by new tissue. Apparently, the spray was just sufficiently injurious to the tissues to stimulate the tree to grow new roots and bark.

Kerosene Emulsion

Nine trees were sprayed July 6, 1912, with 4 gallons each of 10 per cent kerosene emulsion. The earth was removed and not replaced until July 8 owing to threatening showers, which however did not materialize. These trees were all infested. Examination July, 1913, showed every tree badly injured by the kerosene. The small roots were dead and partially decayed and the outside bark around the crowns entirely killed.

Summary

1. Of all the insecticides used Electro Pine Tar Creosote holds the greatest promise due to, first, its power to kill the aphids; second, its strong repellant action and its retention of the penetrating odor after at least twenty-one months in the soil; third, its stimulative effect on diseased tissues, and fourth, the possibility of emulsifying it readily.

2. There is a symbiotic relationship between the aphids and *Lasius* (*Acanthomyops*) *interjectus* Mayr.

There appears to be a congregating habit in *L. interjectus* Mayr., of which it may be possible to take advantage in controlling the ant.

Creosote is an effective repellant for this ant.

3. Paradise stocks show some degree of immunity to attack by the root forms of the woolly aphis.

President H. T. Fernald: The next paper on the program will be read by W. C. O'Kane.

ARSENICAL RESIDUES ON FRUIT AND GRASS

By W. C. O'Kane, *Durham, N. H.*

(*Withdrawn for publication elsewhere*)

Mr. E. G. Titus: I would like to ask a question in regard to the weak animals, as I have had occasion to examine animals with paralysis, and it has often occurred to me that arsenical poisoning might have something to do with the muscular weakness of these animals. It usually occurs in either the fore or hind quarters.

Mr. W. C. O'Kane: The poison is presumed to affect the nerve centers, resulting often in paralysis of the extremities. The calves, if they had been free, no doubt would not have eaten all the grass. They hunted around the edge of the inclosure and tried to get fresh grass. They would eat the sprayed grass freely at the start—ate it promiscuously and then apparently acquired some discernment.

Mr. H. A. Gossard: I would like to inquire whether anyone has any data showing the effect of poison on suckling animals after the mothers have fed on sprayed grass. I recollect an instance in which suckling pigs had died, their mother having fed in a sprayed orchard. The party making the report to me had inquired of a chemist who stated there was danger of the poison being transmitted through the milk, and while little injury was likely to result to the mature hog, the suckling pigs might be injured.

Mr. W. C. O'Kane: I do not know of any data in regard to farm animals that is trustworthy. There are notes as to human beings, especially in English reports of the death of babies that were nursed by mothers who were receiving small amounts of arsenic.

President H. T. Fernald: The next paper will be read by Leonard Haseman.

Mr. Leonard Haseman: This is of course not especially a Missouri pest, but the cotton moth has attracted so much attention in Missouri this year that I thought perhaps a few notes might be of interest to some of the members. Last fall the migration was much heavier than previously. In the latter part of September the migration was so heavy and the damage to fruit so great that we received a very large number of complaints and requests for treatments. As is well known, the cotton moth is able to break the skin of fruit, and it does this seemingly by means of rudimentary jaws. On examining the mouthparts of the cotton moth you will find that it has small rudiments of mandibles.

COTTON WORM

By L. Haseman, *Columbia, Mo.*

For the past three years the moth of the cotton worm has migrated northward across Missouri. In some places it has been more abundant than in others and the damage which it has done to fruits has been considerable each year. The past fall the pest was more injurious than in former years. It began to attract attention early in September and was abundant until frost. It spread rapidly across the state and in two weeks seemed to be generally distributed. In places it was so abundant as to literally cover ripening fruit in the orchard and about cider presses and at night collected about lights as I have never before seen moths collect. Everywhere the moth of the army worm was found associated with it.

Injury Done by Moth.—It is a well-known fact that this moth is able to break the skin of ripening peaches and apples and other fruits. There are cases on record where it has attacked bananas on the city market, though in such cases it very probably selects injured bananas. The moths have a voracious appetite and will feed for hours without stopping after a prolonged fast. The proboscis can be thrust into the flesh of ripe apples and peaches without any trouble and it will reach almost to the pit of an average-sized peach. As the juice is extracted a depression appears which resembles a bruise. This injured tissue is porous and in a short time decay sets in and the fruit is ruined.

Late peaches seem to be the moth's favorite food though it may also attack apples, grapes, pears, tomatoes and other fruits on the markets. In some orchards the crop of Heath Cling and other late peaches was a complete loss this fall. The moths begin feeding about sundown and often completely cover the fruits which they attack. This year they truly assumed the rôle of an important orchard pest.

Work of Caterpillar.—Missouri is not a cotton state though in a few southeastern counties a great deal of cotton is raised and the crop can be grown with profit even as far north as the Missouri river. The cotton worm was very abundant and destructive to the cotton foliage where the crop was not protected by the use of arsenicals. As the moths migrated northward they oviposited on cotton where it was to be found. At Columbia a small experimental plot of cotton was found to be severely attacked by the fifteenth of September and by the first of October the foliage was all consumed. The moths began to lay eggs as soon as they arrived and continued to do so until all the cotton foliage was gone, for on the first of October caterpillars of all ages as well as pupæ were present. Many immature caterpillars migrated in all directions and failing to find cotton died of starvation.

Food Plants.—It is said that this caterpillar will feed only on cotton. From rather extensive observations in the field and from limited cage feeding experiments I have found this to be a fact. In the field, grasses, native weeds, legumes, corn and other plants found around the infested cotton patch were left strictly alone by the migrating and starving caterpillars. In cages, alfalfa, red clover, white clover, cotton weed, morning glory, hollihock, dock were, except for an occasional hole being eaten out, refused by the starving caterpillars.

Natural Enemies.—In this latitude the winter conditions destroy this pest completely and during the summer two parasites assisted. A native ichneumon was found ovipositing in the pupæ and several were bred from pupæ. Some caterpillars were found with the eggs of a Tachina fly on them, though the species was not determined. The caterpillar is so active that it is difficult for the Tachina flies to deposit eggs on it. The boll worm was also found to attack the cotton worm in a few cases.

Mr. H. A. Surface: I found this moth rather abundant in peach orchards last fall and saw considerable damage to Salway peaches. It was not nearly so numerous as was the case two years ago but considerable injury resulted.

Mr. J. J. Davis: It is interesting to note that the moths seem to lay their eggs after migrating. I would like to ask if there is any data regarding egg-laying after the migratory period?

Mr. Leonard Haseman: We made no observations as we did not know the pest was breeding in the vicinity until we saw the caterpillars. It was the first year that we had seen these caterpillars feeding so far north.

Mr. C. T. Brues: We caught quite a number of these moths at an electric trap light at the Bussey Institution, Forest Hills, Mass., but it was impossible to secure eggs from them. They come quite regularly every few years and are apparently too much exhausted by the long flight to deposit eggs.

President H. T. Fernald: A paper will now be presented by H. B. Scammell.

THE CRANBERRY ROOT WORM

By H. B. Scammell, *Pemberton, N. J.*

(*Withdrawn for publication elsewhere*)

Secretary A. F. Burgess: I do not care to discuss the paper, but would like to state for the information of some of the members that several cranberry bogs in Massachusetts were seriously injured

this year by the gipsy moth. There has been slight injury in previous years but the damage was serious in several cases this season.

President H. T. Fernald: The next paper on the program is by W. M. Scott.

ARSENATE OF LIME OR CALCIUM ARSENATE

By W. M. Scott, *Baltimore, Md.*

The possibility of combining arsenic with a cheaper base than lead to produce a safe and effective insecticide for use on fruit and shade trees has no doubt occurred to nearly every economic entomologist. Calcium is the cheapest material that could be used for this purpose and calcium arsenite or arsenite of lime has been recognized as an insecticide for a number of years, but owing to its injurious effect on vegetation it never has and probably never will come into general use.

Arsenate of lime, however, is a more stable and less soluble compound and should, therefore, be less caustic in its effect on fruit and foliage. So far as the writer is aware arsenate of lime is not known in entomological literature and has never been given much consideration. I am informed by Prof. A. L. Quaintance of the United States Bureau of Entomology, that during the past three years his office has conducted spraying experiments with this material and that the results have been uniformly good, although no account of the work has yet been published. For the past two years the writer has endeavored to determine the value of arsenate of lime as a substitute for arsenate of lead and the results obtained at least indicate that this material is worthy of further investigation.

Arsenate of lime may be prepared as a monocalcium, dicalcium or tricalcium arsenate. On the dry basis tricalcium arsenate ($Ca_3(As_2O_4)_2$) contains, theoretically, 42.2 per cent lime (CaO) and 57.8 per cent arsenic oxide (As_2O_5). The material used in the writer's experiments contained 46.8 per cent lime and 47.8 per cent arsenic oxide on the dry basis, and therefore had 11 per cent more lime than would occur in the true tricalcium arsenate. It contained less than 0.05 per cent soluble arsenic oxide. On the basis of 50 per cent of water this material would contain 23.9 per cent arsenic oxide, but in preparing the paste the water content cannot well be reduced below 60 per cent without the use of a filter press.

In the experiments recorded herein the paste was prepared to contain the same percentage of arsenic oxide as is found in standard arsenate of lead, *i.e.*, from 15 to 16 per cent. The rate of dilution for both materials was 2 pounds to 50 gallons of water which gave the same arsenic content in both kinds of diluted sprays.

During 1913, in the Rockfish Valley Orchard, at Avon, Va., 50 Winesap and Yellow Newtown apple trees were sprayed four times with arsenate of lime following the usual schedule, and the remainder of the orchard was sprayed with arsenate of lead. With both poisons, lime-sulphur solution was used as a fungicide in all the applications except the last, in which Bordeaux mixture was used.

The trees were examined from time to time during the season and no difference could be observed between the two kinds of poison, either in their effect on the fruit and foliage or in the control of the codling moth and other insects. No injury was produced and the codling moth was controlled equally well in both cases.

During 1914 a similar experiment on a larger scale was conducted in the same orchard. About 200 Winesap apple trees were sprayed with arsenate of lime and a like number with arsenate of lead and 5 trees were left as checks. As a fungicide lime-sulphur solution was used with the arsenicals and the trees were sprayed (1) after the blossom buds separated, showing pink, (2) as soon as the petals fell, (3) three weeks later and (4) about nine weeks after the petals fell (the first week in July).

Although no actual counts were made it was estimated at picking time that about 60 per cent of the fruit from the unsprayed trees was infested with the codling moth. The fruit from the adjacent trees of the sprayed plots was reasonably free from this insect and no difference could be noted in the efficiency of the two kinds of poison. At the opposite end of the orchard from the check trees, however, the codling moth was not so well controlled and the superintendent was of the opinion that the arsenate of lead had given slightly better results than the arsenate of lime.

In a similar experiment conducted in an apple orchard near Hancock, Md., the powdered form of arsenate of lime was used and here again this poison proved to be the equivalent of arsenate of lead.

During the past spraying season (1914) several apple growers cooperated with the writer in testing this material and, as shown by the following reports, uniformly good results were obtained.

Mr. Fred Johnson, a member of this association and formerly an assistant in the United States Bureau of Entomology, used 50 pounds of arsenate of lime in his orchard at Westfield, N. Y., and in a letter to the writer dated September 28, 1914, he made the following statement in regard to the results:

> I would say that we used this preparation (barium-sulphur crystals) together with the arsenate of lime on three rows of Baldwin trees in one of our orchards at the strength you recommended. All the rest of the orchard was sprayed with home-prepared lime-sulphur and arsenate of lead. This season the whole orchard is as entirely free from scab and codling moth as I could wish, so you may judge that the

results are well nigh perfect. I made several close examinations of the trees sprayed with the dry material and the arsenate of lime and from these observations could see no difference in results from adjacent trees sprayed with the standard formula.

Mr. W. F. D. Batjer, secretary of the Northwest Arkansas Fruit Growers Association, used 50 pounds in his orchard at Rogers, Ark., and under date of November 5, he made the following favorable report on the results:

I used this material on a block of Bens and Ganos in connection with lime-sulphur for the cluster bud, calyx and ten-day spray; on the rest of my orchard I used arsenate of lead in both dry and paste form. The entire crop was remarkably free from curculio and codling moth injury, the arsenate of lime block showing up fully as well as the balance in this respect. One thing that appealed to me in using the arsenate of lime was the fact that it did not change the color of the lime-sulphur solution, leaving it a clear bright yellow, and in my opinion the fruit and foliage in this block had a much better and brighter appearance throughout the season than did that in the balance of the orchard.

Mr. T. W. Ayers, formerly an assistant in the United States Bureau of Plant Industry, used 50 pounds of this poison in an apple orchard at Fort Payne, Ala., during the past season and he has reported that no difference between this material and arsenate of lead could be noted in the control of the codling moth or in their effect on the fruit and foliage.

Through the coöperation of several park commissions and public tree sprayers we were able to have arsenate of lime tested in New England for the control of shade tree insects, and 2,000 pounds were distributed for this purpose. So far as could be learned from reports received the arsenate of lime had the same killing effect on the gipsy moth and brown-tail moth as the arsenate of lead, and there was no injury to foliage reported. In one report it is stated that oak trees were sprayed with this poison for the control of brown-tail moth and that the killing effect was "very good" comparing "favorably" with arsenate of lead. Another report shows that it was used on white oak, red oak and chestnut with results "about equal to arsenate of lead" and with "no injury to the foliage."

On July 1, 1914, the writer had an opportunity to see the results of one of these experiments on the grounds of the Metropolitan Park Commission near Boston, Mass. A clump of small poplar trees infested with the gipsy moth had been sprayed with arsenate of lime and the ground was well covered with dead caterpillars. There were a few live caterpillars still feeding on the sprayed leaves but no larger per cent than was found on adjacent trees sprayed with arsenate of lead.

At Hancock, Md., during the past season the writer used arsenate

of lime on peach trees as a foliage test and found that at a dilution of $1\frac{1}{2}$ pounds (16 per cent arsenic oxide) to 50 gallons of water it almost defoliated the trees. Arsenate of lead used on the same variety caused very little injury, although this arsenical has been known to seriously injure peach foliage under certain weather conditions. It is evident from this test that arsenate of lime is more likely to injure susceptible foliage than arsenate of lead.

It appears from the results of these various experiments that for spraying apple and shade trees arsenate of lime may be used with the same degree of efficiency and safety as arsenate of lead. The chief advantage it has is in the matter of cost, being cheaper than arsenate of lead. It mixes with lime-sulphur solution without causing any chemical reaction which fact might be considered as another advantage, neither material being decomposed by the combination. Unless some unsuspected objection to this new insecticide develops, it would seem a waste of money to continue the use of the more expensive poison.

Mr. Glenn W. Herrick: I would like to ask how much this poison can be sold for?

Mr. W. M. Scott: I cannot answer that question definitely except that there ought to be about the same difference in the cost of arsenate of lime and arsenate of lead as there is in the cost of the lead and the lime used in their preparation, although I have no figures on the cost of manufacture. It is perhaps needless to remark that this paper is not given for advertising purposes because arsenate of lime can be made by anyone; in fact the fruit-grower can make it in his orchard.

Secretary A. F. Burgess: Last spring we secured a barrel or two of arsenate of lime and several areas were treated by Mr. Worthley's men. I would like to ask him to make a statement in regard to the amount of poison used and the general results of the spraying.

Mr. L. H. Worthley: We used about two hundred pounds of poison at the rate of 10 pounds to 100 gallons of water. The results from the standpoint of destroying caterpillars was as good as when arsenate of lead was used, but considerable burning resulted to some of the trees, especially cherry, apple, oak, maple; although almost every species treated showed some burning.

Mr. A. L. Quaintance: Mr. Siegler of the Bureau of Entomology has been working with arsenate of lime, especially as to its home preparation, and I shall be glad if he will state briefly some of the results.

Mr. E. H. Siegler: We have been using arsenate of lime in various

forms, beginning in 1912, for the control of the codling moth and other deciduous fruit insects. During the season of 1914, a commercial arsenate of calcium (paste) containing 18 per cent arsenic oxide (As_2O_5) was tested against the codling moth in our experimental apple orchard, Benton Harbor, Mich. This was used at the rate of 2 pounds to 50 gallons of lime-sulphur solution in comparison with arsenate of lead paste, used at the same rate, combined with lime-sulphur solution. Three spray applications were made: (1) When the petals dropped. (2) Three to four weeks later. (3) Nine weeks after falling of the petals for the control of the second brood.

The arsenate of lime plat included 10 trees, the fruit from 5 of which was examined as it dropped during the season and again at harvest time. The arsenate of lead plat contained 12 trees—6 examined. The unsprayed plat consisted of 8 trees, the fruit from each tree being examined. Each plat produced approximately forty barrels of fruit at harvest, which was inspected for codling moth injury. The arsenate of calcium and arsenate of lead plats gave over 98 per cent of fruit free from the codling moth, while the unsprayed plat yielded about 59 per cent of fruit free from this injury. The foliage of the arsenate of lime plat compared favorably with that of arsenate of lead throughout the season.

We have prepared arsenate of lime by adding sodium arsenate to slaking lime. This arsenical may be prepared from other chemicals, such as a combination of arsenic acid and lime. According to our figures, a good arsenate of lime paste may be made at a cost of two to three cents per pound, exclusive of labor. We have recently purchased fused sodium arsenate (65% As_2O_5) at $8\frac{1}{2}$ cents per pound and stone lime at 75 cents per barrel. From these materials we have made arsenate of lime paste, containing over 20 per cent arsenic oxide, at a cost not to exceed 3 cents per pound. The biproduct, sodium hydroxide, if not removed, may injure delicate foliage. Most of the sodium hydroxide, however, may be readily decanted.

Arsenate of lime was made in the same operation of slaking the lime for Bordeaux mixture for use in an experimental vineyard. No foliage injury resulted.

Arsenate of lime has not been tested sufficiently to warrant an unqualified recommendation. This arsenical may have certain limitations, but it is apparently a promising and cheap insecticide.

Mr. W. C. O'Kane: I would like to ask Mr. Scott whether he has any determination showing the soluble arsenic in the material. You state that there is sometimes burning of foliage and sometimes not. If the free arsenic is a variable quantity, it seems to me that the material offers some risks in its effect on the plants sprayed.

Mr. W. M. Scott: The material used in my experiments ran from a trace of soluble arsenic up to one-half of one per cent. It was uniformly lower in soluble arsenic than arsenate of lead.

President H. T. Fernald: The last paper on the program will be read by Mr. H. A. Surface.

FRAUDS, SEMI-FRAUDS AND QUESTIONABLES

By H. A. Surface, *Harrisburg, Pa.*

(*Withdrawn for publication elsewhere*)

President H. T. Fernald: If there is no discussion, we will now adjourn.

Adjournment, 6.00 p. m.

Afternoon Session, Wednesday, December 30, 1914; 2.00 p. m.

President H. T. Fernald: The first paper on the program will be read by V. I. Safro.

THE NICOTINE SULPHATE-BORDEAUX COMBINATION

By V. I. Safro, *Louisville, Kentucky*

A considerable item of expense in spraying operations is the cost of application. Growers will frequently hesitate to spray, not on account of the cost of the material, but because of the necessity of an additional application. "Fewer applications," is the demand of the grower today in his spraying practice. In choosing one of several materials for spraying, the answer to the question, "Can it be used in combination with other sprays?" will often determine the cheapest spray, and not the cost of the material per gallon. A spray may cost more per gallon but be cheaper in that it does not require a separate application.

In attempting to ascertain the status, last spring, of the advisability of combining Nicotine Sulphate with Bordeaux, we found that there was no consensus of opinion in the matter; in most cases, in fact, the attitude was taken that the combination should not be used on account of possible injury to foliage. This attitude was conservative and proper in that new combinations should not be recommended as long as reasonable doubts exist as to their effectiveness.

The Problem.—Three questions arose regarding the possible results of combining Nicotine Sulphate with Bordeaux Mixture.

1. Is free copper sulphate released as a result of the combination?
2. Does the nicotine sulphate decompose in such a combination?
3. Is the nicotine in the combination precipitated?

The first question would indicate the bearing of the combination on the production of leaf injury.

The second and third questions would, perhaps, indicate the modification in the insecticidal properties of the nicotine in the combination.

Copper Sulphate Not Released.—The 4-4-50 formula was used in making up the Bordeaux for the experiments. The chemical experiments were duplicated with commercial Bordeaux paste with results similar to the results recorded below with home-made Bordeaux. A commercial preparation of Nicotine Sulphate, containing 40 per cent nicotine, was used at dilutions of 1 to 800 and 1 to 1000.

Bordeaux injury on the fruit or foliage is caused by free copper sulphate. In our experiments we used the potassium ferro-cyanide test for free copper sulphate in the Bordeaux before and after the combination with Nicotine Sulphate. The tests were made immediately after combining the two, and one, two and three days later. In none of these cases was free copper sulphate present. To ascertain whether the indicator retained its properties in the combination, some free copper sulphate was added and its presence immediately shown by the dark reaction with the potassium ferro-cyanide.

No Leaf Injury.—Field tests on a small scale were carried on in which Bordeaux 4-4-50, used alone and in combination with Nicotine Sulphate, 1 to 800, were sprayed upon foliage. These tests were conducted on August 16. It is true that foliage-spraying tests carried on so late in the season would not be conclusive in that the same degree of resistance to spray injury does not hold throughout the growing season. However, the plants sprayed included some with tender foliage, and the results may be taken as supplementary to the laboratory findings and the records of other workers. The foliage of the following plants was sprayed: Apple, pear, peach, sweet cherry, sour cherry, black walnut, rose, bean, tomato.

The foliage was examined at intervals of several days—the last examination being made on September 4—almost three weeks after the first application.

Another set of foliage on the same species of plants was similarly sprayed on August 22. In neither case did leaf injury result.

During the period the daily maximum temperature ranged from 75° to 94° and the minimum from 61° to 76°. For four days following the first application there was no rain and for two days following the

second. On nine days the precipitation ranged from .02 to 1.33 inches. In other words, the variations in weather were sufficient for leaf injury to become evident within the three weeks during which the plants were under investigation.

Nicotine Sulphate Not Decomposed.[1]— Two hours after making up the Nicotine Sulphate-Bordeaux combination it was analyzed for nicotine. The chemical record follows:

"The percentage of nicotine, by calculation, in the Nicotine Sulphate-Bordeaux mixture should be 409/10,000 of 1%. (19.255 grams of Nicotine Sulphate—41% nicotine by gravimetric analysis, containing 7.8945 grams of nicotine, were added to 19255 grams of Bordeaux mixture. This gives a calculated percentage of 409/10,000 of 1%).

"The nicotine was distilled from a weighed quantity of Nicotine Sulphate-Bordeaux mixture with steam after the addition of Caustic Soda. The Nicotine in the distillate obtained was determined by the regular Gravimetric Method.

"The actual analysis gives the nicotine content to be 413/10,000 of 1%."

All the nicotine, apparently, was recovered from the combination.

Nicotine Not Precipitated.—The chemical record follows:

"A portion of the Nicotine Sulphate-Bordeaux mixture was removed, filtered and washed with distilled water. The filtrate was tested for nicotine, and washing continued until no more nicotine passed through the filter.

"(50 c.c. of original Nicotine Sulphate-Bordeaux was used; the wash water amounting to about 400 c.c., used in portions of 40 c.c. each.)

"The filter paper with its copper precipitate was introduced into a distilling flask, caustic soda added, and steam distillation conducted as in regular nicotine distillations.

"The distillate was tested for nicotine with Silicotungstic Acid and not the slightest precipitate was obtained.

"(Silicotungstic Acid will show a precipitate with nicotine in a dilution of one in 300,000.)"

Injury Following the Combination Explained.—Instances have been reported in which foliage injury followed the use of the combination, and these cases of injury were often the bases of recommendations to apply the two sprays separately.

The cases of injury apparently belong to the same category as the injury sometimes following the combination of Nicotine Sulphate with lime sulphur or with arsenate of lead or arsenite of zinc. The latter combinations are widely recommended; still, occasional reports of injury are heard. These cases are perhaps explained, as far as the combination itself is concerned, when we consider that under certain conditions lime sulphur, arsenate of lead and arsenite of zinc will cause injury even when used alone. As is well known, the same holds true of Bordeaux mixture. In none of the cases of reported injury have we

[1] The nicotine determinations in these experiments were made by Mr. H. K. McConnell, Assistant Chemist of The Kentucky Tobacco Product Co.

been able to find that Bordeaux alone had been used at the same time and under the same conditions. In other words, though Nicotine Sulphate may be used in combination with Bordeaux, it will probably not prevent any injury that the Bordeaux would cause if used alone. This fact, however, need not affect the recommendations for combining the two sprays.

Successful Use of the Combination by Others.—Though the general attitude was conservative and the combination not generally recommended, records of its successful use were beginning to accumulate.

A few of the following records were published, but most of them were obtained through correspondence in answer to letters of inquiry. (This is not intended as a complete list but includes merely instances that have come to our attention.)

Professor Watkins, University of Illinois, has used the combination for five years with excellent results.[1]

W. B. Parker, Bureau of Entomology, used the combination for the hop flea beetle in 1909. No leaf injury was reported and the insecticidal properties of the combination were retained. The author considered that where the beetles were numerous and a large percentage around the vines, a Bordeaux-tobacco mixture should prove effective.[2]

Fred Johnson, Bureau of Entomology, used the combination successfully in 1911 on nymphs of the grape leaf hopper.[3]

Hartzell, New York Experiment Station, used the combination successfully for the nymphs of the grape leaf hopper in 1912.[4]

Beach, Iowa Experiment Station, in 1912 recommended the combination and that soap be not used with it.[5]

Sanderson,[6] in his book "Insect Pests of Farm, Garden, and Orchard," states that tobacco extracts may be added to Bordeaux mixture to save a separate application.

G. P. Gray, Chemist, California State Insecticide Laboratory, examined our laboratory methods and records and stated that the experiments seemed to be quite conclusive. Professor Gray's tests showed that no soluble copper was produced by mixing Bordeaux with the ordinary tobacco extracts found upon the market.[1]

Professor M. B. Waite tested the combination last summer on cantaloupes on his own farm. No foliage injury occurred and the Bordeaux

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[1] In correspondence.

[2] Bureau Entomology, Bul. 82, pt. IV.

[3] Bureau Entomology, Bul. 116, pt. I.

[4] New York (Geneva) Station Bul. 359.

[5] Iowa Station Bul. 127.

[6] Page 608.

and Nicotine Sulphate were apparently as effective as if they had been used separately.[1]

H. A. Gossard, Ohio Experiment Station, states that the combination has been used on grape foliage with no bad results by coöperators of the Station.

H. S. Price, Horticulturist, Virginia Experiment Station, states that as a result of experiments in Virginia they believe that the combination may be used without danger of burning foliage and without lessening the insecticidal value of the tobacco extract.[1]

Similar tests and results were obtained by T. J. Headlee, New Jersey Experiment Station.[1]

H. F. Wilson, Oregon Experiment Station, conducted a number of experiments with the combination and found that the insecticidal value of the Nicotine Sulphate did not seem to be at all impaired. No injury was caused by the application.[1]

Miscellaneous Remarks.—It should be noted in our experiments that we used commercial Nicotine Sulphate. *Free* nicotine will combine with free copper sulphate, precipitating the *copper*. We have not investigated the result of adding *free* nicotine to Bordeaux and are not in position to make any statements concerning the safety of such a combination.

It has been stated by Professor Gray and others that the possibility existed that certain nicotine preparations containing much extractive matter would tend to dissolve the copper of the Bordeaux mixture. We have not investigated this matter and have no data bearing upon this phase of the problem.

At this point we would state that the terms "tobacco extract" and "nicotine solutions" are not synonymous. The term "tobacco extract" is understood by the trade to mean an aqueous extract of tobacco which therefore necessarily contains the water soluble ingredients of tobacco. "Nicotine solutions" are understood by the trade to mean more or less highly concentrated solutions obtained by processes other than aqueous extraction.

Conclusion.—These results and records indicate that Nicotine Sulphate may safely be added to and applied with Bordeaux in all cases where Bordeaux alone may be safely used.

President H. T. Fernald: The next paper on the program is by P. J. Parrott and W. J. Schoene.

[1] In correspondence.

THE INSECTICIDAL PROPERTIES OF VARIOUS SULPHIDES AND POLYSULPHIDES

By P. J. Parrott and W. J. Schoene

(Abstract)

Recent years have witnessed the appearance on the market of a large number of spraying mixtures which derive their efficient properties from sulphides and polysulphides of sodium, potassium, calcium and barium. Most of these are in liquid form, but three preparations in a powdered or granular state, containing sulphides of sodium, potassium and barium respectively as their chief constituents are now offered for sale. It appears that methods for obtaining calcium sulphides in dry form have been devised, but so far only liquid preparations of these compounds are handled by dealers in spraying supplies. The amount of sulphur in proprietary insecticides containing sulphides and polysulphides of the different bases varies greatly, ranging for the sodium preparations from 1.79 to 58.92 per cent; potassium, 2.39 to 38.72 per cent; calcium, 3.97 to 26.40 per cent, and barium 16.54 to 44.0 per cent.

The variation in amounts of sulphur in the commercial mixtures reveals a need of definite information as to the comparative insecticidal properties of the foregoing sulphides as a basis for safe and specific recommendations. To obtain data as to the relative merits, experiments have been conducted for the past two years in which the compounds have been tested on the basis of their sulphur content, the sulphides and polysulphides of the different bases being used at varying strengths to give similar ratios of sulphur respectively in the dilute mixtures.

In experiments against the San José scale, using the compounds at the rate of four and three-fourths ounces of sulphur to a gallon, there were variations in effectiveness on individual trees, especially in apple orchards, which were, however, fairly distributed among the várious plats. As gauged by blemishing of fruit, production of young scales and infestation of new wood, it was difficult to perceive that one preparation had any appreciable advantage over another. If the compounds do really differ in effectiveness, these results suggest that the differences in efficiencies are not great and apparently are such as could easily be overcome either by more thorough spraying or by slight additions to the sulphur content of the dilute mixtures or by the incorporation of inexpensive substances to increase toxic properties. The work in general so far points to the conclusion that the strength of a preparation with regard to its sulphur content is a more impor-

tant consideration than the nature of the base of the sulphides and polysulphides. On the assumption that the compounds of the different bases are equal or nearly equal against the scale, the chief factors that enter into a choice of a proprietary insecticide are safeness to foliage when combined with arsenate of lead and economy, in which respects the advantage appears to lie with the calcium and barium sprays, the former being less expensive of the two.

In tests to determine their values as stomach poisons, none of the compounds alone, apparently, including those of barium, were harmful to various species of leaf-eating caterpillers or beetles. In most instances arsenate of lead with the sulphides and polysulphides of sodium and potassium was somewhat quicker in manifesting its toxic properties than when combined with the other compounds, which may be explained by the formation of soluble arsenic in the reactions between the poison and the sulphides. Because of the chemical reactions, the sodium and potassium sulphides, while more rapid in their poisonous effects upon insects, were generally much more liable to cause injuries to the foliage of fruit trees than the calcium and barium compounds in combination with arsenate of lead.

According to their nature and mode of action, various substances are incorporated in spraying mixtures to give penetrating and adhesive properties. The agents that are commonly used are silicate of soda, saccharates, soap, glue, gelatine, resin, and home-made and commercial oil emulsions. Tests show that glue, soap, glycerine, sodium silicate and oil emulsions of various formulas may be combined with the sodium and potassium sulphides, and that similar combinations are possible with the calcium and barium sulphides except in the case of soap and oil emulsions. As to the influence of such combinations on effectiveness, no marked results have been observed, except when soap and oil emulsions were employed with the sodium or potassium sulphides against aphides or oil emulsions with the same sulphides for the control of the San José scale. The principal gain in the latter case appears to be in an increased rate of toxicity. The destructive action of the sulphides alone on the scale is apparently slower, and while prolonged over a more extended period may, however, prove no less efficient.

President H. T. Fernald: The next paper is by W. M. Scott.

A NEW CONTACT INSECTICIDE

By W. M. Scott, *Baltimore, Md.*

Lime-sulphur solution is by far the most important contact insecticide now in use, and in tonnage it probably equals, if it does not exceed, all the other insecticides, combined. It is unique in that it is both an insecticide and a fungicide and has a wider range of usefulness than any other spray material. Applied to fruit trees in the dormant season it serves to control the San José scale, oyster-shell scale and some other insects, as well as the peach leaf-curl disease. In the growing season it is used for the control of apple scab, apple leaf-spot, "red spider" and several other plant pests. It has largely supplanted the oils and soaps as scale remedies and has partly displaced Bordeaux mixture as a fungicide.

On the other hand, this material is unpleasant to prepare on the farm, bulky and heavy to transport and difficult to store without loss from leakage and evaporation. Owing to these objectionable features there has arisen a desire among fruit-growers for a "dry lime-sulphur" or a dry material that could be used as a substitute for lime-sulphur solution in the control of insects and diseases. Attempts have been made to produce such a material by reducing lime-sulphur solution to dryness, but the polysulphides of calcium upon drying decompose and become insoluble, thus largely losing their insecticidal value. Calcium thiosulphate, one of the ingredients of lime-sulphur solution, is soluble in water but experiments have shown that it is not an efficient insecticide. It therefore becomes necessary to employ some other base as a carrier for the sulphur. The results of experiments conducted by the writer during 1913 and 1914 show that barium is a satisfactory material for this purpose.[1] Professor Parrott in his paper, just presented, has shown that a solution of barium and sulphur is fully as effective as lime-sulphur solution in the control of the San José scale.

Barium and calcium belong to the same mineral group and the polysulphides of these two bases, being so closely related, might be expected to possess about the same insecticidal and fungicidal properties. One important difference in the two materials is that the polysulphides of barium, or at least one of them, can be produced in the form of soluble crystals while those of calcium cannot.

Boiling a given quantity of barium sulphide (BaS) in water with all the sulphur that it will take up produces a solution composed chiefly

[1] The chemical work in connection with these experiments was performed by Mr. C. B. Clark, a chemist of the Thomsen Chemical Company.

of barium penta-sulphide (BaS_5) which when reduced to dryness under suitable conditions forms barium tetrasulphide (BaS_4H_2O) and free sulphur. This dry material also contains some thiosulphate (BaS_2O_3). As prepared for the writer's experiments it analyzes approximately as follows:

BaS_4H_2O	85%	Total sulphur 47%
Free sulphur	7%	
BaS_2O_3	5%	Total barium 45%
Impurities	3%	

The tetrasulphide occurs in the form of reddish yellow crystals of the rhombic system and it is readily soluble in cold water. The free sulphur and thiosulphate also largely dissolve in the tetrasulphide solution, leaving about 4 per cent of the material as insoluble residue.

Spraying Experiments

During the dormant season of 1913–14 the writer conducted experiments for the control of the San José scale in Virginia, West Virginia, Pennsylvania and New York and in no case could there be observed any material difference in the killing effect of the barium product and lime-sulphur solution. The results of an experiment conducted in a ten-year-old apple orchard at Sleepy Creek, W. Va. are shown in Table I. Trees moderately infested with the San José scale were selected and the spraying was done on December 5, 1913. In making the examination on April 29 and June 8, the old weather-beaten scales that were evidently dead before the spraying was done, or that died naturally during the winter, were, of course, not counted, so that the percentages given in Table I include only those scales that could be expected, normally, to pass the winter alive.

Table I. San José Scale Experiment, Sleepy Creek, W. Va., December 5, 1913

Plot	Materials	Oz. to 1 gal. Water	Per cent Scale Dead 4–29–14	Per cent Scale Dead 6–8–14
1	Calcium thiosulphate	16	59	60
2	Calcium sulphide	6	83	90
3	Lime-sulphur sol. 33° B.	20	95	97
4	Lime-sulphur sol. 33° B.	15	95	96½
5	Barium-sulphur sol. 33° B.	20	95½	98¾
6	Barium-sulphur sol. 33° B.	15	95	99½
7	Barium-sulphur sol. 33° B.	28	100	99½
8	Dry barium-sulphur	12	96	99
9	Dry barium-sulphur	12	95	..
10	Check	Unsprayed	51½	..

The barium-sulphur solution mentioned in Table I is analogous to lime-sulphur solution and was made by boiling the simple sulphide

of barium with sulphur. The dry barium-sulphur is the material already described, the chief ingredient of which is barium tetrasulphide.

It will be noted that the barium product killed the scale quite as effectually as the lime-sulphur solution, and that there was practically no difference in the effect of the dry form and the solutions. Calcium thiosulphate had no material effect on the scale, while calcium sulphide apparently did. However, these two materials were used on only one tree each which is not sufficient for conclusive results. The barium products were used on about 200 trees.

Another experiment comparing the dry barium-sulphur product with lime-sulphur solution in the control of the San José scale was conducted in a three-year-old orchard near Hancock, Md. This orchard is composed of peaches and apples interplanted, and the plots were so arranged that each contained at least one apple and one peach tree badly infested with the San José scale. About 200 trees were sprayed with the dry barium product and a like number with lime-sulphur solution. The application was made on March 25 and 26, 1914, and the trees were examined several times during the spring and summer. The results of examinations made on May 30 and July 4 are shown in Table II.

Table II. San José Scale Experiment, Hancock, Md., March 25–26, 1914.

Plot	Materials	Lbs. to 50 gals. Water	Per cent Scale Dead 5-30-14	Young Alive 7-4-14
1	Dry barium-sulphur (a)	16	99½	None
2	Dry barium-sulphur	24	100	"
3	Dry barium-sulphur	32	100	"
4[1]	Lime-sulphur sol.	59	99¾	"
5	Dry barium-sulphur b)	16	99¾	"
6	Dry barium-sulphur	24	99½	"
7	Dry barium-sulphur	32	99¾	"
8	Dry barium-sulphur (c)	16	100	"
9	Dry barium-sulphur	24	99	"
10	Dry barium-sulphur	32	100	"
11	Dry barium-sulphur	10	99½	"
12	Check	Unsprayed	50	Many

(a) represents the dry BaS_4H_2O with all the impurities, (b) the same material with most of the impurities removed, and (c) the same as (b) but prepared in a somewhat different manner.

[1] Plot 4 was sprayed with lime-sulphur solution (32°–33° Beaumé) diluted at the rate of 5½ gallons (59 lbs.) to 50 gallons of water.

As shown by the figures in Table II there was practically no difference in the insecticidal effect of the barium-sulphur crystals and lime-sulphur solution. An examination on May 30 showed from 99 per cent to 100 per cent of the scale dead on all the sprayed plots and 50 per cent on the unsprayed plot. On July 4, crawling and newly settled

young were found in abundance on the unsprayed trees, but none could be found on the badly infested trees which had been marked for examination in each of the sprayed plots. Subsequent examinations made on August 19 and November 27 showed no change in the results except that the infestation on the unsprayed trees grew steadily worse.

In 32 pounds of the dry barium product there is about the same amount of sulphur as is contained in 59 pounds ($5\frac{1}{2}$ gallons) of the lime-sulphur solution used and yet 16 pounds of the former material to 50 gallons of water were sufficient to control the San José scale. A dilution as weak as 10 pounds to 50 gallons of water apparently killed the scale, as shown in plot 11, but this strength was used in only the one experiment and the results should, therefore, not be considered conclusive. However, the strength of 16 pounds to 50 gallons of water was used in several different orchards with uniformly good results, which would indicate that, when combined with barium, less sulphur is required to kill the scale than when combined with lime.

An experiment for the control of the oyster-shell scale was conducted in the laboratory at Baltimore and here again the dry barium-sulphur product proved to be as effective as lime-sulphur solution. On March 3, 1914, poplar branches badly infested with this scale insect were placed in jars of water in a warm room and sprayed with these materials. A similar branch was left unsprayed as a check. The branches threw out roots from the cut surface in the water and kept alive long enough for the conclusion of the experiment. The old female scales were gorged with eggs which began to hatch on April 2, when 83 young were counted crawling over the unsprayed branch. No young were out crawling on any of the sprayed branches but by removing a few mother scales it was found that the eggs were beginning to hatch.

At the conclusion of the experiment, April 17, all of the eggs on the unsprayed branch had apparently hatched and the writer counted 300 young which had settled down and formed a scaly covering. On the branch sprayed with barium-sulphur (BaS_4H_2O+), 5 ounces to 1 gallon of water, about 90 per cent (estimated) of the eggs hatched and most of the young died without emerging from beneath the mother scales. Thirty-four young had succeeded in emerging but only two of these remained alive. On the branch treated with 7.7 ounces of barium-sulphur to 1 gallon of water, all the young died without emerging from beneath the mother scales. On a third branch treated with 10 ounces of barium-sulphur to 1 gallon of water the same results were obtained, except that 30 young emerged, all of which died without settling down. On a branch sprayed with 1 pint of lime-sulphur solution to 50 gallons of water, 300 young issued but all died without settling down.

During the growing period of 1914 spraying experiments were conducted in several apple orchards to determine the fungicidal value of barium-sulphur as compared with lime-sulphur solution. It was diluted at the rates of 3 pounds and 6 pounds of the crystals to each 50 gallons of water and was used alone, in combination with arsenate of lead and in combination with arsenate of lime. Fungous diseases, such as apple scab and apple leaf-spot, were controlled by this material to about the same extent as by lime-sulphur solution, and no injury to fruit or foliage was produced.

Also, 50 peach trees were sprayed with barium-sulphur, 3 pounds to 50 gallons of water, about three weeks after the petals fell and again one month later. Arsenate of lead ($1\frac{1}{2}$ pounds to 50 gallons) was added to the solution in the first application, but not in the second. No injury to fruit or foliage was produced and peach scab (*Cladosporium carpophilum*) was thoroughly controlled. This would indicate that barium-sulphur is less likely to injure vegetation than lime-sulphur solution which is known to be quite injurious to peach foliage.

Mr. J. S. Houser: I would like to ask the cost per pound of barium sulphide?

Mr. W. M. Scott: The cost so far as the manufacturers are concerned has not been worked out definitely. My understanding is that it will cost about four cents a pound and that at that price the original cost at the factory will be a little more than lime-sulphur solution but the difference will be made up by the difference in freight.

One thing I did not call attention to and that is that with 10 pounds to 50 gallons of water, it controlled the scale just as well as it did at 16 pounds or at 32 pounds. In other words, it would seem that when combined with barium the sulphur is somewhat more effective than when combined with lime, or rather, that much less sulphur is effective when combined with barium than when combined with lime, which, if this proves true, would make the barium product cheaper than the lime-sulphur solution.

A Member: I would like to ask if this is in the form of crystals that can be reduced to dry powder?

Mr. W. M. Scott: The formula is BaS_4H_2O, but it can be ground to a powder.

Mr. R. L. Webster: I would like to ask in regard to destroying the eggs of the oyster-shell scale, how did you determine that the eggs were killed?

Mr. W. M. Scott: I did not intend to say that it killed the eggs of the oyster-shell scale. What I intended to say was that it appar-

ently prevented some of the eggs from hatching. Practically all of the eggs on the unsprayed branches hatched while 10 per cent or more of those on the sprayed branches failed to hatch and dried out. Barium-sulphide is fully as caustic and objectionable as lime-sulphur; so far as we have been able to determine, it keeps indefinitely; that is, we have had it for more than a year and it has not decomposed yet. Upon long exposure open to the air, it will gradually oxidize and a fine powdery substance accumulates on the outside of the crystals which amounts to a very small percentage after standing for more than four or five months.

Mr. T. B. Symons: I presume it would have about the same effect on leaf curl as lime-sulphur.

Mr. W. M. Scott: The fact that it has done everything that lime-sulphur has done in all of the experiments would lead us to believe that it would act about the same on leaf curl, although we have not had an opportunity to try it on that disease. We sent some to California and Mr. Foster made some experiments on lemon trees for red spider and other mites, comparing it with lime-sulphur solution. He obtained something like 98 per cent efficiency in controlling the citrus red spider and there was no injury to the foliage, while lime-sulphur solution applied at the same time scorched the foliage. It looks as though there is a promising field for this material in citrus spraying.

Mr. P. J. Parrott: In regard to the fungicidal properties of barium-sulphide, I will say that we used it in solution last spring with satisfactory results to control apple scab.

President H. T. Fernald: The next paper will be read by J. W. McColloch.

RECENT RESULTS IN THE USE OF DUST SPRAYS FOR CONTROLLING THE CORN-EAR WORM

By James W. McColloch, *Assistant Entomologist, Kansas Agricultural Experiment Station*

The corn-ear worm (*Heliothis obsoleta* Fab.) has long been recognized as one of the most difficult of the staple crop pests to control. A study of its life economy shows that there are a number of factors in the life cycle of this insect that are prohibitive of complete control and that the best that can be hoped for is a material reduction in the amount of injury: first, the larvæ feed almost entirely within the curl of the corn plant or within the ear where they are inaccessible to parasitic enemies and where as yet it is impossible to reach them with a spray; second, the larvæ are able to feed and develop on a wide

range of host plants; third, the adult moths are strong fliers and are able to travel readily from one field to another; and, fourth, the females are capable of depositing from five hundred to two thousand eggs, the eggs being laid singly and generally only one on a plant.

Numerous measures for the control of this pest have been advocated from time to time and some of them have proved effective in reducing the amount of injury. While the greater part of these measures are cultural in nature and aim at the prevention of the injury by the destruction of the insect before it infests the plant, a few of the measures advocated are remedial ones and are directed at the destruction of the insect after it infests the plant. Probably the most generally recommended remedial measure is that of poisoning. As early as 1879 Professor Comstock recommended the use of Paris green, either with water or dry with flour, as a means of destroying this insect on cotton.

Spraying as a measure of controlling the corn-ear worm on corn not only has received much prominence during the last few years but also seems to be growing in favor, and from a number of different sources good results have been reported in regard to its effectiveness.

Six years ago the Department of Entomology of the Kansas Agricultural Experiment Station took up a study of this method and since then the work has been carried on more extensively each year. It was found that a large percentage of eggs deposited during the summer were placed on the fresh corn silks and that the worms causing the injury to the ear originated from these eggs. The young larvæ on hatching from the eggs begin feeding on the silks and eating their way down into the ear. From the data thus accumulated it seemed possible to control a larger percentage of the injury by keeping the silks sprayed during the silking period.

As a preliminary to certain general spraying experiments some work was done to determine what poison could be used most effectively against the corn-ear worm and at the same time not be injurious to the silks. From the results of this work it was found that powdered arsenate of lead was the most efficient poison.

During the past six years in Kansas the average number of ears of corn injured by the corn-ear worm ranged from 85 to 95 per cent and from 5 to 25 per cent of the grains on these ears have been injured, either by the worm or by the accompanying moulds and fungi. Much of this injury has been so severe as to render the corn unfit for feed or for seed or show purposes.

During the past summer the department of entomology, in coöperation with the Union Sulphur Company, carried on a series of dusting experiments. Three plots, each one-third acre in extent, were dusted

with different strengths of Corona dry arsenate of lead. The silks in Plot 1 were dusted with 100 per cent arsenate of lead, those in Plot 2 with 63 per cent arsenate of lead, and those in Plot 3 with 50 per cent arsenate of lead. Sulphur was used as a carrier of the lead in Plots 2 and 3. A fourth plot was kept for a check. The dust which was applied by shaking from an ordinary cheese-cloth bag was applied every three days during the time the silks were fresh. No attempt was made to get the poison on any other part of the plant. Owing to the dry weather the applications were made more frequently than would ordinarily be necessary. The results of this experiment are shown in the table.

Table Showing the Results of Dusting Corn to Control Ear-Worm Injury

Plot	Treatment	Cost			Per Cent Ears Injured	Per Cent Grain Injury	Amount Mould Injury	Yield
		Poison	Labor	Total				
1....	100% A. of L.	$3.36	$1.76	$5.12	63	Less than 1%	None	10.7 bu.
2....	63% A. of L.	1.82	1.61	3.43	66	Less than 1 %	None	12.6 "
3....	50% A. of L.	2.20	1.70	3.90	88	About 5%	Moderate	12.5 "
4....	Check				98	About 10%	Bad	11.9 "

While over 60 per cent of the ears in Plots 1 and 2 were injured by worms the damage was so slight as to be almost negligible. In almost every case only one or two grains were injured on each ear and the usual moulds and fungi which accompany corn-ear worm work were not present. In the check plot the injury due to the ear-worm and to the accompanying moulds and fungi was so bad that much of the corn was unfit for feeding to stock, especially to horses.

The results of the past summer show that the 63 per cent mixture controlled the corn-ear worm practically as well as did the pure arsenate of lead. The difference in cost, however, was about $5.00 less per acre in favor of the 63 per cent arsenate of lead.

From the results given in the table it is seen that the cost of this treatment is prohibitive where corn is grown for forage and grain purposes. It is the opinion of the author that this cost can be reduced fully one-half by lengthening the period between applications to five days and by using a cheaper carrier, such as hydrated lime. This, however, would still make the cost at least $5.00 per acre. Where corn is raised for show purposes or for seed and roasting ears, dusting can be recommended as being very profitable. Sweet corn can be sold on the market for from five to ten cents more per dozen ears when it is known to be free from ear-worm injury.

The following conclusions may be drawn from the results thus far obtained:

(1) The amount of corn-earn worm injury can be greatly reduced by the thorough dusting of the silks.

(2) The cost of this treatment is prohibitive where corn is raised for grain and forage purposes.

(3) This treatment is profitable where corn is grown for roasting ears, show purposes or for seed.

(4) Sixty-three per cent arsenate of lead is equally as effective as pure arsenate of lead and costs less.

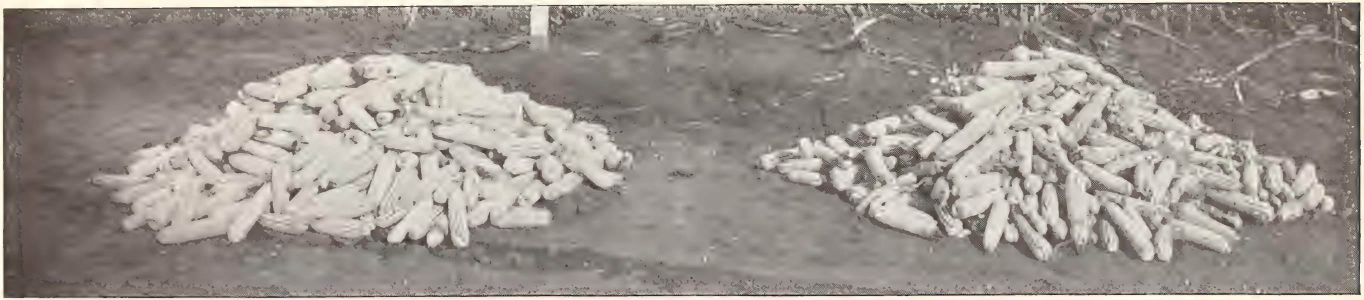
President H. T. Fernald: The next paper will be by Leonard Haseman.

THE CORN-EAR WORM

By L. Haseman, *Columbia, Mo.*

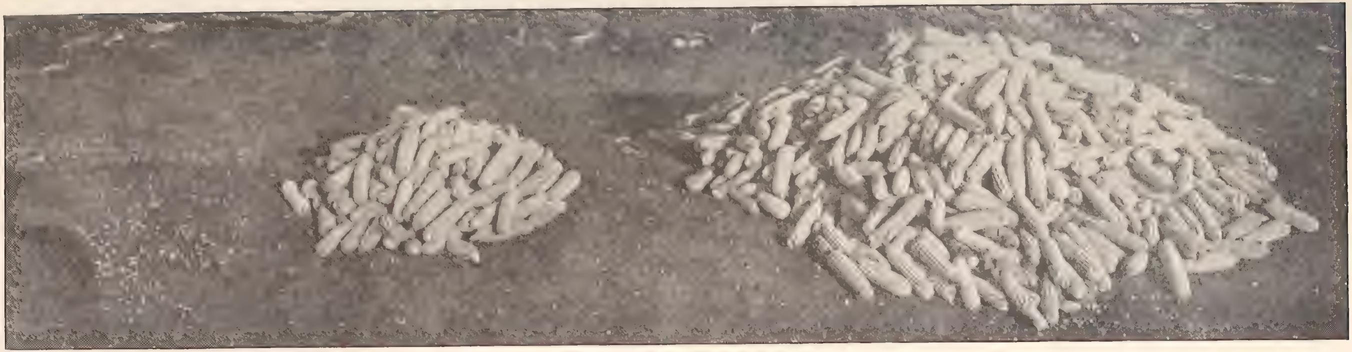
During the past few years this pest has been unusually abundant in Missouri and has done an enormous amount of damage to corn and other crops. Mild winters with dry summers followed by early fall rains seem to provide the most favorable conditions for this pest. Our records of the past three years seem to prove this. This pest has been on the increase for the three years just past and since the generally recommended precautions and remedies have given little relief, an attempt is being made to study the life and habits of the insect more carefully in hopes that some treatment may be devised which will prove more effective in controlling this pest. The work is scarcely begun so these remarks will be confined to those facts which we have been able to work out during the past year.

Food Plants.—Corn is clearly the favorite food of this pest, though it feeds readily on other plants and plant parts. Early in the season the caterpillar works down in the growing tip of the corn. Its work in the ears begins at "shooting" time and may continue until the grains are dry and hard. Green tomatoes are also badly attacked, especially in the fall. Cotton where it is grown is also a favorite food, the caterpillars boring into the bolls and feeding on the seeds and fiber. The caterpillars are also destructive to beans, peas, cowpeas and other legumes which develop pods. Late in the fall they may attack the succulent growth on alfalfa, clover and other plants. They feed largely as borers though they may feed exposed on the foliage and tips of plants. They are very voracious when hungry, often feeding on each other or other species of caterpillars. They are, therefore,



100% Powdered Lead Arsenate

63% Powdered Lead Arsenate



50% Powdered Lead Arsenate

Check—No treatment
Piles on left show uninjured ears, piles on right injured ears

quite general feeders, especially late in the fall when they are not confined to cornfields by any means, which makes it impossible to reach them with winter plowing.

Life History.—The number of broods a year in Missouri has not been carefully worked out if in fact there is a definite number. It is a question as to just how many broods occur before the ears form. After the ears form the broods so overlap that it is difficult to differentiate them, though from our breeding records it is evident that there are a number of broods a year.

Egg.—The female ovaries contain as many as 1000 eggs in all stages of development. It is not likely that all are matured and deposited, though judging from the number of eggs found on the silks of one ear this is not unbelievable. Egg laying must last several days. Eggs are invariably placed on the corn silks the first night they are out. In some cases 70 eggs have been found on the silks of a single ear. Most of the eggs are stuck to the silks though some are deposited on the shucks.

Caterpillar.—The eggs hatch in about three days on an average, so that the worms are at work on the silks almost as soon as pollenization has been completed. At first the caterpillars are too small for the average eye to detect them readily. They feed at first on the fleshy silks and as they increase in size, follow the silks down to the grains and feed on them. Later other eggs are deposited on the tips of ears so that small and large worms are found in the same ear. In some cases one caterpillar may form a tunnel almost the full length of the ear, though more often it destroys all the grains at the tip.

The average length of the larval period is $18\frac{1}{2}$ days and has been found to vary from 16 to 21 days.

Pupa.—Pupation occurs in the soil or rarely under moist rubbish. The depth to which the caterpillar bores before pupating varies. In breeding jars with from one to three inches of sand or soil they bore to the bottom invariably.

The pupal period in the fall varies from 7 to 18 days with an average of 14 days.

Adult.—The moth is very active and feeds on nectar of flowers and juices of fruits. It flies and feeds during the day as well as at night. This is especially true on cloudy days. The eggs are not all matured at the same time and evidently the food taken is used in maturing the eggs during the egg-laying period.

The length of the life of the adult moth was not determined except in case of moths reared and confined in breeding cages. Under those conditions the moths soon die, the average life being 5 days. In nature the life period of the moth is evidently much longer. This must be determined.

Extent of Injury.—During the past summer and fall 75 to 80 per cent of field corn grown in bottom land which had been in corn last year and winter plowed was attacked by this pest. The extent of this injury to each ear varies but the total loss is at least 10 per cent of the crop. In case of fall grown sweet corn 100 per cent of the ears were attacked with practically a complete loss of the crop. With such damage as this the total loss throughout the corn belt amounts to several millions of dollars.

The actual damage does not stop with the corn which is consumed but fungus growths of the smut type follow up the work of the worm and destroy much more of the corn. Some of these smuts seem to have poisonous properties and some veterinarians attribute the poisoning of stock fed on wormy corn to these smuts. If this is true the pest is indirectly responsible for such losses. In the past three years a great many animals have been lost due to poisoning in this state.

Experiment for Preventing Injury.—Since it is not possible to reach the pest successfully with remedies generally recommended and since coöperation of farmers is not possible, an attempt has been made to find some treatment of corn which will protect the crop during the growing season. The pest being one which feeds first on the silk and later enters the ears, it was thought that some treatment of the ears at "shooting" time might accomplish this.

We have used a number of materials both in the form of a spray and as a dust. It is necessary that the material used must not injure the silks or ears and if it is to give results it must either poison the young worms or repel the moth or worms. The repellents used have given no results so far. The poisons in some cases injured the corn, in other cases gave no results, while in case of powdered arsenate of lead the damage was reduced from 75 to 35 per cent.

This work is to be continued along those lines which have proven most successful. This year we used 5 acres of field corn and one-fourth acre of sweet corn in our experiments. While at present the results seem rather discouraging I believe an economical treatment can be found that will save the corn crop.

Mr. Wilmon Newell: I would like to ask Mr. McColloch whether he made any observations on the feeding of the larvæ on the silks before they made their way inside the shuck.

Mr. J. W. McColloch: They may feed for a few hours after hatching. They feed on the egg shell first and then start down into the ear. We have not carried on very much work along that line but they move pretty rapidly to the ear and probably within six hours after they hatch they are down in the tip of the ear.

Mr. T. J. Headlee: I think Mr. Richardson can tell us something about this.

Mr. C. H. Richardson: Experiments were made summer before last in which we found that the young worm was in the apex of the ear within twenty minutes after hatching. These were laboratory experiments. I was not able to prove this in the field as the difficulties of observation were many. There was very little feeding until the worms were within the apex of the ear well hidden in the silk. I think the efficiency depends on a little of the insecticide deposited on the silks sifting downward as the silks grow out.

A Member: I would like to ask if good results have been obtained with hydrated lime, as we found it was very difficult to prevent a separation of the arsenate of lead and the hydrated lime.

Mr. J. W. McColloch: As far as I know hydrated lime has not been used very extensively. The chemical company with which we coöperated this year suggested its use in the place of sulphur.

Mr. T. J. Headlee: At one time we collected a little evidence on the use of lime as a diluent for powdered arsenate of lead. Generally speaking these tests showed no injury. In some cases, however, the collection of the lime and lead at the axils resulted in the bleaching of the leaf at that point. This was not, however, the universal rule, indicating that the constitution of the lime was variable. As a matter of fact, it is extremely probable that the air-slaked lime used was not yet entirely changed and that the bleaching occurred when the lime was still caustic. The physical nature of lime seems well adapted to serve as a diluent for the powdered lead, but its caustic nature must be changed.

I should like to ask a question on my own account. I should like to inquire whether Mr. Haseman or Mr. McColloch have made use of a mechanical distributer of the poisons, and what results they have gotten, if any.

Mr. Haseman: Would simply say that our machine will powder off—a thin dust.

Mr. McColloch: We used an ordinary cheesecloth bag.

Mr. Headlee: I asked that question because in the summer of 1913, Mr. Richardson of our department made a thorough test of a horse machine. This distributer was devised by the late Mr. Karl R. Wundt and the speaker and built by the Dust Sprayer Manufacturing Company of Kansas City, Mo. The mixture was delivered as dust under pressure and gave the whole corn plant, especially the ear, a fine coating of the poison. It was tried in Missouri by Mr. Wundt in the summer of 1912 with excellent results. In our test it failed to effect control. A careful study showed that it failed because the young

worm in most cases penetrated the silk below the poison before attempting to feed. The maintenance of the small pile of dust placed on the silks in course of hand application caused the poison to filter down between the silks as they grew and kept the very zone in which feeding began poisoned. In this way the hand applied poisons effected satisfactory control while the machine applications failed.

Mr. F. C. Bishopp: Mr. McColloch is to be congratulated. The control of the boll worm is certainly rather difficult in the case of corn. It seems apparent that they do not have the worm as badly in these two states, Kansas and Missouri, as we had farther south. In Texas for instance, almost 100 per cent of the ears are infested in certain localities. The number of worms is apparently much greater. There we have found that often corn ears are infested by larvæ which hatch from eggs deposited on the husks or somewhere else than on the silk, within one day or less after the silk begins to put out. You would have to begin your poisoning the minute the ear begins to show silk. Another point, I fear we will experience much difficulty in getting this poisoning system established in many of the corn-growing regions. While it may be practical on a rather small scale, it is doubtful if the same method will be generally applicable.

Mr. Leonard Haseman: We also get worms in every ear of late corn so that not merely 70 or 80 per cent but 100 per cent injury occurs in the case of late maturing corn.

I would like to ask Mr. McColloch if he has used poisoned bait for the moths; and also if he notes any difference in the work of the pest on ears which have been opened slightly just at "shooting" time? We seem to find that if we open the ears slightly at the tip, we have less worms than where they are untouched.

Mr. J. W. McColloch: We tried the poisoned baits on moths and also attempted to catch them in fly traps, but the results were practically negative.

Mr. T. B. Symons: I would like to ask Mr. McColloch as to diluting arsenate of lead?

Mr. J. W. McColloch: Sixty-three per cent arsenate of lead contains 63 parts of arsenate of lead and 37 parts of sulphur.

President H. T. Fernald: I would like to say as a matter of record in addition that during the twenty-eight years that the Experiment Station in Massachusetts has had an Entomological Department, four cases, I believe, of the occurrence of the corn earn worm have been recorded, all of these from the extreme southern or southeastern portion of the state, from the territory that I have in my address alluded to as rather typically southern in its nature.

President H. T. Fernald: The next paper will be read by Mr. George A. Dean.

FURTHER DATA ON POISONED BRAN MASH FLAVORED WITH FRUIT JUICE AS A MEANS OF CONTROLLING SOME INSECTS

By GEO. A. DEAN, *Entomologist of the Kansas Agricultural Experiment Station*

GRASSHOPPERS

Last year the writer read a paper before this association describing how the grasshopper outbreak in Western Kansas was successfully controlled by distributing over the infested areas poisoned bran mash flavored with either orange or lemon juice. In that paper it was stated that almost one thousand tons of poisoned bran mash were distributed in twelve counties, totaling an area of twelve thousand square miles and that from 60 to 80 per cent of the grasshoppers were killed by the one application. In the discussion that followed the writer further stated that the adverse conditions produced by the dry, hot weather probably played a considerable part in the unusual results accomplished. However, during the past season the same poisoned bait was thoroughly tested in several localities where the climatic conditions were entirely different from those of Western Kansas and the reports from these districts are equally as good as those had in Kansas. In an editorial of the August number of the JOURNAL OF ECONOMIC ENTOMOLOGY we find the following statement relative to the use of the bait in New York: "A localized though widespread outbreak of the redlegged grasshopper and several associated forms was quickly handled in threatened grain fields by the use of the Kansas bait, brought to notice only last year. Dying insects were to be seen within four hours after the distribution of the bait and within three days about four-fifths of the grasshoppers in a field were dead." A letter of November 12, 1914, from Mr. Arthur Gibson, chief assistant entomologist of the Dominion of Canada, states: "You will be interested to know that we had excellent results with the Kansas formula flavored with lemons in Ontario and Quebec provinces. Near Ottawa counts made diagonally across fields of oats, etc., gave 50 to 414 dead locusts to the square yard. The cost was 25 cents per acre including labor. In Quebec province the application of the mixture was even more remarkable, the results being from 900 to 1,200 dead insects to the square yard. The cost was 18 cents per acre exclusive of labor."

This year in Kansas the poisoned bait was used under entirely different conditions than those of the summer of 1913. There was no general outbreak of grasshoppers but there were several local infestations in the central and even in the eastern parts of the state, and during the late summer and early fall the grasshoppers were in sufficient numbers

to seriously threaten the new alfalfa and the new wheat. They came into these crops from adjoining fields, pastures and roadsides, and had the farmers not been prompt in the distribution of the bran mash the grasshoppers would have seriously injured the crops. The farmers were in close touch with the situation and just as soon as the grasshoppers moved into the edge of the alfalfa or new wheat, a strip of the poisoned bran mash was scattered broadcast early in the morning along the edge of the crop into which they were moving. If they had already spread into the fields the bran mash was sown over the infested portions. It was scattered in such a manner as to cover about five acres with the amount of bait prepared by beginning with twenty pounds of bran. Inasmuch as the grasshoppers kept coming into the alfalfa and wheat from adjoining fields, it was necessary in several cases to make a second and even a third application of the bait at intervals of from three to four days. In practically all cases where the bran mash was used the farmers were successful in destroying the grasshoppers.

Army Worms

The past season was an unusual one in Kansas for serious outbreaks of insects, consequently there were several opportunities to thoroughly test the value of poisoned bran mash for the control of insects other than grasshoppers. One of the first insects to appear was the army worm (*Leucania unipuncta*). It appeared in devastating armies in many localities over a large portion of the eastern half of the state. In some instances from ten to fifteen acres of corn and several acres of garden crops were completely destroyed in a single night. Alfalfa fields of from ten to one hundred acres were soon devastated. Fortunately, the army worms were discovered early enough in the season to give a few days to prepare to meet them. Eight or ten days before the farmers were aware of the danger threatening them, the army worms were discovered in corn fields that previously had been in rye. In fields of this sort the dust barrier was impracticable because the worms were distributed all through the field. Poisoned bran mash flavored with oranges was at once sown broadcast. Within two hours the worms were dying and the next day from 90 to 95 per cent of them were dead. In other fields where the worms had already destroyed the corn and were moving into nearby corn fields or into garden crops, it was impossible to check them by means of a dust barrier or a ditch because of rainy weather. A strip of bran mash was sown just in advance of the worms. So effective was the bait that the corn and garden crops on the other side of the strip were unmolested.[1]

[1] It should be stated that while several of the experiments were being conducted the army worms were feeding and moving during the day. It was cloudy and slight rain was falling part of the time.

On finding the poisoned bran mash practically one hundred per cent effective, not only under different climatic conditions but also with the worms infesting different crops and moving in different manners, the writer felt safe in recommending it as the most practical and effective method of controlling the army worm. No time was left for further experiments. The department, through the county demonstration agents and its special reporters, was in close touch with the situation over the state. On May 30 the general warning was sent out by wire and by letters calling attention to the seriousness of the infestation and urging immediate action. The next day the daily papers gave wide publicity to the serious outbreak and recommended the use of the bran mash, the dust barrier, and spraying with an arsenical spray. Within two days several of the county agents through the bankers' associations and county clubs and by the use of the rural telephones had their counties not only organized but had the farmers already distributing the bran mash. In nearly all cases the farmers were prompt in organizing and putting into operation the methods of control recommended. If the worms were moving into an adjoining field a strip of the bran mash was sown broadcast along the edge of the field into which they were moving. If they were already in a field of corn and the corn was small, the bait was sown broadcast down in the lister furrows. If the corn was larger, it was scattered so that a small portion of the mash dropped in the curl. If they were abundant in an alfalfa field the crop was cut at once and the worms destroyed as they were moving into an adjoining field. If they were working on alfalfa that was just starting up after it had been cut, the bait was sown broadcast over the infested field. Instructions were given to scatter the bran mash in the evening unless the worms were working or moving during the day, which they did on cloudy and slightly rainy days.

In nearly all cases the results were excellent. Many of the reports from the county farm agents stated that large numbers of the worms were dead within thirty minutes after the poisoned bait was applied and within two hours the majority were killed. One of the men of the department stated that in one case the army worms were coming into a corn field from an adjoining field of rye. To reach the corn they had to pass through an osage orange fence and during the day they congregated along the hedge in large numbers, and undoubtedly would have moved into the corn at night. Since there were hundreds of worms to the square yard along this fence it was an ideal place to distribute the bait. A heavy sowing was made just before noon under the hedge and along the rye field. Within thirty minutes hundreds of dead worms were found. Within two hours the ground was covered with dead ones and practically every small depression was filled with

them. Counts made in average places along the hedge showed over two hundred dead worms per square foot.

Such excellent coöperation was had from nearly all the farmers, and so well organized were many of the counties—credit for which should be given to the county farm agents—that within less than two weeks the army worm infestation was completely under control and instead of a loss of some five or six million dollars to agricultural crops (which would be a conservative estimate of the damage if the worms had not been destroyed, and a loss that actually did take place in an adjoining state) the damage in Kansas was considerably less than a million dollars.

Variegated Cutworm

It is nothing unusual in Kansas for the variegated cutworm (*Peridroma saucia*) to appear in great numbers in local districts and take on the habits of the army worm. In the spring of 1909 the infestation of this insect, which was more severe than usual, extended over several counties in the south central part of the state. At that time they appeared in the early spring and destroyed thousands of acres of wheat and many acres of alfalfa. The writer as well as two other men of the Experiment Station spent several days in the field endeavoring to find an effective method of control. The ordinary poisoned bran mash did not prove effective and was soon discarded as an ineffective and an impracticable method of control.

The infestation of last spring was a much wider one, extending over almost the same territory as that infested by the army worm. In fact, in many cases the army worms were associated with the cutworms in the alfalfa fields. Instead of injuring crops early in the season and confining their attack almost entirely to wheat as they did in the previous infestations, they appeared almost sixty days later or about the first of June, and the main injury was confined to the alfalfa, although in a few cases after the alfalfa had been cut, they migrated into garden truck and corn.

The first crop of alfalfa was cut during the last of May and the first week in June. If army worms were present they at once moved into the adjoining fields of corn, wheat, or garden truck, but in nearly all cases the cutworms remained in the alfalfa. Climatic conditions were very favorable for a rapid growth of the second crop, which was sufficient to hold the cutworms, although apparently it did not entirely satisfy their appetites. Within two or three days the farmers noticed that the alfalfa was not growing and that the ground was just as bare as the day the alfalfa was cut. An examination of the fields soon showed that the worms were eating the new growth of alfalfa just as soon as it appeared. Although the worms did not get enough to sat-

isfy their hunger during the night, they did get enough to eat to keep them from migrating, and with the advent of day they entered the ground to wait for the next night's meal. This made conditions ideal for poisoning them. In the evening the bran mash flavored with oranges or lemons was sown broadcast over the infested fields. It was sown in such a manner that the amount of bait prepared by beginning with twenty pounds of bran covered about five acres. In nearly all cases the results were practically one hundred per cent effective. One application was sufficient. In some cases the morning after the application of the bran mash from one hundred to five hundred dead worms were found per square yard. In fact, one could scarcely believe so many worms were present until he saw the enormous number of dead ones the next morning.

The Black Cricket

In many parts of Kansas last summer there appeared an unusually large number of black crickets of which the most common species was *Gryllus pennsylvanicus*. The crickets, attracted to the lights, soon found their way into dwelling houses, warehouses, and stores of all sorts. In houses they concealed themselves during the day under heavy pieces of furniture and in closets. Frequently they were found in large numbers in the basement. Seemingly they sought the basement not only to find suitable hiding places but also to get away from the heat. In the dwelling houses and dry goods stores they cut curtains, clothing, and fabrics. In two instances at Manhattan they seriously injured rubber goods stored in the basement.

After a few experiments it was found that the most practical and effective method of destroying them was to distribute poisoned bran mash prepared in the following manner:

Bran	1 lb.
Paris green	1 oz.
Syrup	3 oz.
Orange or lemon	$\frac{1}{4}$ of a fruit
Water	$1\frac{1}{2}$ pts.

Here, again, the bait when flavored with orange or lemon seemed not only more attractive but also more appetizing and thus was readily eaten by the crickets. Small amounts of the bran mash were put in shallow pans or dishes and placed in the closets, behind and under heavy pieces of furniture, in the basement or any place frequented by the crickets. In the basement the bait was also placed in teaspoonful lots in the corners, behind boxes and other hiding places. The crickets, like the grasshoppers, do not eat the poisoned mash so readily when it is dry, thus it should be distributed in the evening because the crickets work mostly at night.

Mr. W. E. Britton: I would like to ask Mr. Dean if he tried this on cutworms?

Mr. George A. Dean: The variegated cutworm, the outbreak of which was discussed in my paper, is also one of the common garden cutworms. Although we have not tried this poisoned bran mash for the control of cutworms in gardens, we have tried the other bran mash (not flavored with fruit juice) and it proved fairly effective. Since the bran mash proved so effective in the control of the variegated cutworm in the alfalfa fields, I can think of no reasons why it would not also be effective in destroying the cutworms in gardens.

Mr. E. O. G. Kelly: I would like to ask if the insects prefer the poisoned bran over the crop they are attacking?

Mr. George A. Dean: Yes, in many of our experiments we have found this to be true. I am sorry I neglected to bring the slides, which I had intended to bring and which would have illustrated this very distinctly. For instance, on one side of the bran mash barrier the rows of corn, about eighty rods long, and at that time the plants about fifteen inches high, stand absolutely uninjured, while on the other side of the barrier the corn is completely taken. In the case of grasshoppers we have found that they would leave the alfalfa and take the bran. In the case of army worms in alfalfa, as stated in my paper, we recommended the cutting of the alfalfa and then poison the worms as they migrate. In most of our work the alfalfa was either ready to cut or had been cut. Personally, I would not advise the scattering of it in alfalfa fields where the crop or plants are large. First cut the alfalfa and then distribute the bran mash.

Mr. Wilmon Newell: In Texas we have used this mixture extensively the past year in the case of local grasshopper outbreaks and the results have been uniformly satisfactory. In one case we distributed the poisoned bran mash in a field of green oats that were just heading. The grasshoppers preferred it to the green oats and the crop of oat hay was saved. It was impossible to cut the oats and apply the mash afterwards for the weather was too wet. Its use in this case saved the entire crop.

Mr. H. A. Surface: Any effects of poisoning native birds or domestic animals from its use?

Mr. George A. Dean: I will state that in all of our distributing of the poisoned bran mash we have yet to hear of any authentic case of poisoning any barnyard fowl or domestic animal in any way, shape or manner. We have noticed bees about it, but in no case have we found them dying. No birds have been killed. Professor Dyche, of the Kansas University, who is Fish and Game Warden of Kansas, with headquarters in the part of the state where the bran mash was

distributed last year in the control of grasshoppers, has to my knowledge, found no instance of it killing birds. Of course, if it were placed out in handful lots, as was formerly recommended, there probably would be no question about it killing birds, but when the mash is distributed in such a manner that twenty pounds will cover five acres, there is absolutely no danger. We have had chickens, turkeys, and hogs following right after us while sowing it in alfalfa fields. They do not get enough to harm them.

Mr. W. C. O'Kane: If army worms are feeding in corn say two or three feet high, of course during the daytime they are often curled up in what is left of the leaves of the corn. Suppose you have six or eight or ten army worms per stalk of corn, as I think we had, and they were down in these unfolding leaves, would it be necessary either to get the poisoned bran mash down into these leaves or to get some on the stem or stalk of the corn?

Mr. George A. Dean: In most of our work the corn was not nearly so high as you mention in your case. If the corn were fairly large we tried to sow the bran mash so that some of it not only fell down in the curl, but also lodged on the blades, and in many cases the worms ceased at once to eat the corn and ate the bran mash. We also noticed in many cases that where the bran mash was scattered along the base of the plant they would leave the corn and eat the poisoned bait. This corn was not very high. If the corn were large and you could not get the particles of bran mash on it conveniently, I would sow it on the ground along the row so that they would find it when they moved on to another plant.

Mr. E. P. Felt: Do you consider it safe to sow the poisoned bran mash in fairly liberal quantities so that it will drop down in the leaves of the corn?

Mr. George A. Dean: I have no data on this at all. I simply know that our corn was so small that there was absolutely no danger, and I believe this will be true in any case where the corn is not over two feet high. If the corn were large, say in the silk, there might be, in case the bran mash were sown rather liberally, some danger, if enough of it lodged down in behind the blades, of it proving harmful in case the corn were used for feed.

Mr. W. S. Regan: During the past summer we had a rather serious outbreak of the army worm in eastern Massachusetts. We used bran mash to kill the worms and we did hear of some cases where birds were killed by the bran mash. I know of one case where a farmer reported having found 11 blackbirds after he had scattered the bran mash over the fields; it also killed some of his chickens and turkeys. I did not see these.

Mr. George A. Dean: Did he scatter it as thin as twenty pounds to five acres?

Mr. W. S. Regan: Yes. He used only about ten pounds for a trial and this amount was scattered over an area of several acres according to his statement. I could hardly believe anything else could be responsible for it under the conditions.

Mr. George A. Dean: In our work we often receive reports of it killing chickens and turkeys. We have taken the trouble in several cases to investigate these reports but in no case have we found any evidence of arsenical poisoning. In several cases where the fowls were dead, death seemingly was due to eating too many of the hoppers. The hind legs of the hoppers had caused a stoppage and apparently death was due to inflammation. It is nothing uncommon to lose a number of young turkeys if they are allowed to gorge themselves on grasshoppers. A young turkey, like some other animals, when it finds something good to eat hasn't any more sense than to eat too much. If barnyard fowls are obliged to run down the grasshoppers they are not so apt to gorge themselves, but if they find large numbers of dying grasshoppers in under trees or in shady places they are very apt to overload in feeding on them. As stated before, if a person uses a little judgment in the distribution of the bran mash, there is no danger of it injuring birds or barnyard fowls. I might state that Kansas stands very high in the number of species of birds, and after distributing almost a thousand tons of bran mash, as we did in the summer of 1913, it would seem that if birds were eating a sufficient amount of the bran mash to kill them, we would have at least a few cases to report.

President H. T. Fernald: The State Ornithologist of Massachusetts looked into some reported cases in Massachusetts and was satisfied that the birds were killed by eating the mash—though how thoroughly he investigated I cannot say.

Mr. E. G. Titus: A few years ago we had occasion to take up the question of chickens dying in an orchard where poisoned bran mash had been used. On opening their stomachs, none of the bran mash was found, but in every case they were filled with grasshoppers, and it appeared that they had died by being choked with excessive numbers of these insects. We also found on examination that no injury resulted to sparrows in sections where the poisoned mash was used.

A Member: I would like to say that a careful observer in Michigan reports that birds will not touch poisoned bran if orange or lemon juice is used in it.

Mr. W. S. Regan: We had very good success with barriers to prevent the migration of the army worm caterpillars. First, the plowed furrow retarded their advance. Powdered air-slaked lime dusted

heavily along the furrow aided materially in checking them. We noticed that the caterpillars were not inclined to pass through the lime, turning about and getting out of it as soon as they came in contact with it. Poisoned bran mash scattered along the furrow killed practically every caterpillar. Ordinary road oil also proved an effective barrier. It was applied with a garden watering-can, the spraying top of which had been removed, making a strip a couple of inches wide about the field to be protected.

Mr. T. J. Headlee: Three-fourths of the damage done last summer in New Jersey by army worms occurred in lawns. Generally over the state and especially along the shore, lawns were so eaten that they turned brown and seemed dead. Arsenate of lead (dry and wet) poisoned bran mash (without fruit juice) were used, with only partial success. Mr. W. B. Duryee, Jr., the farm demonstration agent in Monmouth County, devised a scheme which worked better than any other tried. Shallow ditches were dug along paved walks, walls and building foundations. Finely pulverized lime was dusted lightly over the infested lawns, taking care to keep the ditches free from it. The following morning the worms were found collected in the ditches and were destroyed by sprinkling them with gasoline. The gasoline was used instead of kerosene because it left no undesirable stain upon the walks, walls and foundations. In nearly all cases a single treatment proved sufficient to free the infested lawn from further trouble.

For general field crops and garden infestation barriers have again demonstrated their value over poisons. The trench 12 inches deep and 8 inches wide with 6–8 inch-deep post holes along its bottom at distances of from 10 to 20 feet was completely effective, the worms collecting in the holes and being destroyed by crushing or by sprinkling them with kerosene. It was also found that the ordinary oil treatment accorded to macadam roads when freshly applied rendered the road a complete barrier. Advantage of this discovery was taken to protect threatened truck fields.

President H. T. Fernald: The next paper will be read by Mr. E. P. Felt.

GRASSHOPPER CONTROL IN NEW YORK STATE

By E. P. Felt, *Albany, N. Y.*

New York State suffered last summer from an almost unprecedented grasshopper outbreak, the injury being confined largely to the sandy areas bordering the Adirondacks and extending from Poland, Herkimer County, through Fulton and Saratoga counties north to Warren and Clinton counties. *Melanoplus atlanis* Riley was the principal

offender, though *Melanoplus femoratus* Burm., *Camnula pellucida* Scudd. and *Dissosteira carolina* Linn. were also present and in some localities rather abundant, this being particularly true of Camnula at Wells. The outbreak was a culmination of one or more years of grasshopper abundance which seemed to be greatly favored by unusually dry weather in May and June, while the pests were in immature stages. The limitation of the outbreak to sandy, especially wild or semiwild areas was very evident, and although there was some drifting of the grasshoppers with the wind from field to field, in general the pests were local in habit. Injury to buckwheat was quite characteristic in that the young grasshoppers invaded the fields from the grassy or bushy fence rows and destroyed all of the grain for a variable distance of one to three, and in some cases ten rods, the middle portion of the field being almost uninjured and comparatively free from the pests. A noteworthy feature was the abundance of grasshoppers in the cities of Gloversville, Saratoga and Glens Falls, in particular, especially the first named. There were times when the insects were so numerous that they were swept from the sidewalks and it was by no means uncommon to see 15 to 25 or more on a limited portion of the outside of a building or a fence. Complaints began to be received in early June and by the middle of July the outbreak was at its height.

Throughout the region there was a general feeling that it was comparatively useless for the individual to take up what seemed to be a very uneven conflict. With the above conditions in mind a large scale demonstration was started July 18 by the entomologist, in coöperation with agents of the State Department of Agriculture. The Kansas bait used so successfully elsewhere last year was employed and the mixture distributed over a badly and uniformly infested twenty-acre oat field, beginning about 10.30 in the morning, a good handful of the bait as sown covering approximately two hundred square feet. The distribution was so extended that one had to look closely in order to find the bait. Observations showed that many grasshoppers began to feed upon it within three or five minutes, and in some instances they seemed to drop from the oats, probably being attracted by the smell and gradually make their way to small particles of the mash. About four hours after the first application a few sick grasshoppers were observed here and there. At 6.30 the next afternoon, less than thirty-six hours after the beginning of the treatment, three-fourths of the grasshoppers in the field were dead or dying, 12 to 14 dead insects being easily found on a square foot and frequently six or seven were seen collected in small crevices as many inches long. Three days after the application it was estimated that about four-fifths of the grasshoppers were dead, 67 being found in one square foot and an

average square yard contained 26 dead grasshoppers, another one 64. Five days after the bait was distributed, sick grasshoppers were still to be seen, though there had been a heavy two-hour rain the day before and the efficiency of the mash was therefore probably decreased. The next day it was estimated that over .9 of all the grasshoppers originally in the field had been destroyed, and at the end of a ten-day period the fatalities approached 99 per cent. The cost of the materials was estimated at 13 cents per acre. Observations lead us to believe that the wider the distribution the more effective the results. This poison was not only tested in fields where grasshoppers were abundant and consequently had destroyed much of the more succulent vegetation, such as the new seeding and the younger leaves of the grain, but it was also used in several oat fields where there had been practically no injury and the new seeding was therefore thrifty and luscious. Even under such apparently adverse conditions, so far as efficiency of the poison is concerned, the insects freely ate the poisoned bait and succumbed before they were able to cause any material injury. The Criddle mixture was used by some farmers with almost equally good results though it is not nearly so easy to prepare. The experience of last summer also showed the advisability of protecting the nostrils with a moistened sponge and the avoiding of the poisoned dust so far as practical in the case of parties who are required to mix large quantities of the poison. There is a source of danger here which should be safeguarded against at the outset, otherwise serious results might follow.

We were unable to learn of any deleterious effects resulting from the use of this material when ordinary precautions were observed. The moist sweetened bran is very attractive to domestic animals and therefore great care should be exercised to prevent their gaining access to containers used for mixing or distributing the material. We distinctly advise against putting out the poison in small spoonfuls or masses, partly because there is greater danger of poisoning domestic animals, and also on account of the increased efficiency accompanying a sparse distribution. Under most conditions we would expect practical immunity from grasshopper injury following one application of the bait, even though the grasshoppers were allowed to remain unmolested in badly infested adjacent fields.

Mr. S. J. Hunter: Regarding the effects on the nostrils of the workers, it appears that Dr. Felt has found it about the same as we have in the west, where mixing such large quantities, our workers found it desirable to use gasoline propelled cement mixers. When issued,

however, to the farmers, the requisite amount of Paris Green was put in the center of each sack, and the farmer instructed to mix according to directions when he reached home.

President H. T. Fernald: The next paper will be read by Mr. Wilmon Newell.

NOTES ON THE INSECT ENEMIES OF SUDAN GRASS

By Wilmon Newell, *College Station, Texas*

As Sudan grass[1] has, through the publicity given it by the Bureau of Plant Industry, U. S. D. A., and the Texas Experiment Station, become a forage crop of much importance in Texas and the Southwest, mention of some of the insects attacking it may be considered timely.

The insect enemies of this crop thus far observed are not new to entomologists, but are comprised of insects which are already quite well known on account of their ravages on other crops.

The Sorghum Midge

First in importance is the sorghum midge, *Contarinia* (*Diplosis*) *sorghicola* Coq., on account of its destruction of the seed before maturity. This Cecidomyid is well known on account of its attacks on sorghum, milo maize and related crops, there being many localities in the South where the midge entirely prevents the maturing of seed. It attacks Sudan grass with equal facility and, while not injuring the crop so far as forage is concerned, it makes the production of seed well-nigh impossible in heavily infested sections. Inasmuch as the seed has thus far sold at prices varying from $1.00 to $1.50 per pound, the monetary loss is very considerable.

The sorghum midge is essentially an insect of humid sections and in localities of heavy annual rainfall, as in southern Louisiana and Mississippi and in the southeastern portion of Texas, it seems improbable that Sudan grass seed will ever be produced successfully.

In Texas the extent of damage appears to vary considerably with the seasons. The only portion of the state entirely exempt from the midge is the western part where the annual rainfall is usually less than 25 inches.

During the past two years Sudan grass has been grown, not only at the main Experiment Station at College Station, but also at each of the eleven sub-stations and this has given us a good general knowledge

[1] *Andropogon sorghum.* var. Recently described by Prof. C. V. Piper, of the Bureau of Plant Industry, as variety *sudanensis.*

of the distribution and abundance of the insect. The following table shows the location of these stations, the annual rainfall and the estimated damage to the Sudan seed crop during the past two seasons:

RAINFALL AND INJURY TO SUDAN GRASS SEED

Station	Average Annual Rainfall		Estimated Damage to Seed Crop, Sudan Grass	
	Length of Record, Years	Inches	1913	1914
Angleton	18	49.54[1]	100%	95%[2]
Nacogdoches	7	45.44[3]	60%	100%
Troup	9	43.79	100%	100%
Beaumont	20	42.65[4]	20%	100%
College Station	24	37.87[4]	40%	95%[2]
Chillicothe	8	33.64	None	None
Temple	28	33.36[4]	None	50%
Denton	1	33.14	15%	50%
Beeville	18	30.05[4]	None	50%
Lubbock	3	21.74	None	None
Spur	3	18.40	None	None
Pecos	4	7.93	None	None

[1] U. S. Weather Bureau record at Alvin, 20 miles from Angleton.
[2] A small seed crop produced very late in the season.
[3] U. S. Weather Bureau record at Lufkin, 15 miles from Nacogdoches.
[4] U. S. Weather Bureau record.

This table shows that localities having an average annual rainfall of 35 inches or more have experienced almost total destruction of the seed crop for the past two years, whereas localities with an average rainfall of about 25 inches or less have been exempt from damage. Between these two extremes, *i. e.*, in localities where the average rainfall is between 25 and 35 inches, the amount of damage has been highly variable.

Sufficient data are not yet at hand to permit of any positive correlation between local climatic conditions and the extent of midge injury. However, it appears in general that, the greater the precipitation during the spring and early summer months, the greater is the damage by the midge. This is indicated by the data following:

Spring and Summer Precipitation and Midge Injury

Station	1913		1914	
	Rainfall, May, June and July, Inches	Damage by Midge	Rainfall, May, June and July, Inches	Damage by Midge
Beaumont	9.66	20%	32.64	100%
College Station	4.03	40%	9.45	95%
Temple	5.02	None	16.02	50%
Denton	8.44	15%	4.77	50%
Beeville	5.45	None	12.62	50%

As pointed out by Dean,[1] the only remedial measures thus far evident consist in clean harvesting, the complete destruction of Johnson grass and possibly the fumigation of seed to kill the hibernating larvæ. Johnson grass is a favorite host plant of the midge, its seed heads afford protection to the midge larvæ and its early heading in the spring gives opportunity for a generation of midges to be produced in advance of the heading of cultivated crops.

Sudan grass, in the latitude of central Texas, would produce two and sometimes three, seed crops per season were it not for the midge, but in seasons of heavy infestation there only remains the possibility of securing a very late crop of seed at a time when the parasitism of the midge is high. Thus at both College Station and Angleton in 1914, a partial late crop of seed was secured, though earlier crops of the seed were entirely destroyed.

The Conchuela

Strangely enough, the area which is too dry for the sorghum midge is the one in which the conchuela, *Pentatoma ligata* Say, reaches its greatest abundance. While this plant-bug is a general feeder, attacking cotton, small grains, alfalfa, foliage of trees, garden vegetables, etc., it is particularly avaricious in its attack on all members of the sorghum family. In Loving County during the past season it even prevented, to a large extent, the seed production of Johnson grass. Thus far large areas of Sudan grass have not been grown in the localities where the conchuela is at present abundant, but, owing to its fondness for all other members of the sorghum family, there seems little doubt that it will prove to be a serious obstacle to the extended cultivation of Sudan grass in the semi-arid sections.

[1] Bul. 85, Part IV, p. 58, Bureau of Entomology.

One of our correspondents, Mr. A. S. Whitten, of Porterville, Texas, has observed these insects hibernating in piles of wood, weeds and trash generally. The method of hibernation would suggest, as remedial measures, the early deep plowing of infested fields and a thorough winter cleaning up and burning of all rubbish affording hibernating quarters for the insect. Morrill[1] also recommends the destruction of all mesquite trees in the vicinity of infested fields, as the mesquite is one of the favorite native host plants of the insect.

The Angoumois Grain Moth

The Angoumois grain moth, *Sitotroga cerealella* Oliv., readily infests the seed of Sudan grass both in the field and in storage. During September and October, 1914, the moths were noted in great abundance among the heads of the uncut grass at Robstown, Texas, as well as in the shocks of harvested grain awaiting threshing. During the warmer days of November, also, they were abundant around the bins in which the seed had been stored.

Fortunately, Sudan grass seed shows a high resistance to injury by carbon bisulphide. In experiments which we have made to determine whether its germinating power might be affected by heavy fumigation it was found that as much as 15 lbs. to the 1000 cubic feet of bisulphide, confined for 12 hours, did not affect germination. In some instances the fumigation even appeared to stimulate germination of the seed. The germination tests were made in seed testers, both immediately after the fumigation and again nine weeks later. The results of a few of these fumigations are given in the table below:

Germination of Sudan Grass Seed Fumigated with Carbon Bisulphide at Different Strengths

Date of Fumigation	Amount of CS_2 per 1000 Cubic Feet	Per Cent of Germination, Sept. 5–10	Per Cent of Germination, Nov. 16–20
Sept. 1–5	1 lb.	91	90
Sept. 1–5	3 lbs.	88	90
Sept. 1–5	5 lbs.	97	91
Sept. 1–5	8 lbs.	83	94
Sept. 1–5	10 lbs.	91	91
Sept. 1–5	15 lbs.	86	78
(Not fumigated)	Check No. 1	86	83
(Not fumigated)	Check No. 2	86	83

[1] Bul. 89, Bureau of Entomology.

Other Insects

Like other grasses and small grains, Sudan grass is subject to attack by grasshoppers, cutworms, army worms, grub worms, etc. It is also to be expected that the stored seed will be found subject to attack by the usual seed-infesting insects, such as the saw-toothed grain-beetle, the granary and rice weevils, etc., but instances of such infestation have not yet come to our attention.

President H. T. Fernald: The next paper will be presented by Mr. S. J. Hunter.

SOME ECONOMIC RESULTS OF THE YEAR

Bees and Poison Bran Mash; Army Worms; Intermittent Seasonal Spraying

By S. J. Hunter, *University of Kansas, Lawrence*

To economize time, it has seemed desirable to summarize some of the economic work of the year under the one general head, rather than to present the same in several papers.

In the conduct of any field campaign, objections to some feature, as every entomologist knows, are likely to be raised, and these objections, to secure the undivided support of all concerned, have to be met.

Objections regarding the danger to stock through the use of arsenical poisons are of common occurrence. Two years ago, during the extensive use of the poison bran mash against the native grasshoppers, the question was frequently asked as to what effect the poison would have on bees, when distributed through a large alfalfa field where bees from large apiaries were at work. Last summer, Professor Caesar, of Ontario, wrote me that similar inquiries came to him from Apiarists. Under date of July 24, last, Professor Caesar writes:

> The bee-keepers of Ontario are alarmed at the supposed danger to the bees which they believe attends the use of your remedy for grasshoppers. I have used this remedy this year and saw no bees feeding on it. It has given good satisfaction as a treatment for grasshoppers. I should, however, be very pleased if you would kindly let me hear, as soon as possible, whether bees have been poisoned by it to any extent in Kansas. Sincerely,
>
> (Signed) *L. Caesar.*

In order to satisfy ourselves even more fully on this subject, Mr. George H. Vansell, our Apiary inspector, undertook a series of experiments to determine whether the bees would feed at all on the poison bran mash; and if so, under what circumstances, and with what results.

First, to determine whether the bees would partake of the poison at all, small piles were placed on the running board of the hives. Here, the bees did not go out of their way to come to the piles, but those which ran against it, stopped and began to lap up the mixture quite greedily, sometimes starting off, to return to lap again. Such were retained, and all died within three hours.

A number of bees were confined in a bell-jar with this poison. After a time, the bees came down and sipped the mash contentedly; they would then fly to the top of the jar, to return again for more of the sweet mixture. All those confined in the bell-jar partook of the mash and died; but on the running board of the hive, only 15 of those that passed over it during an hour's observations stopped to taste it. When the bran mash was scattered about a few feet from the hive, not a single bee halted to taste the substance.

Second, the bran mash was distributed in a sweet-clover patch where bees were unusually abundant and not one was observed feeding, or in any way being drawn toward the mixture. It was also distributed freely among rotting peaches on the ground where bees were feeding in large numbers, with similar results.

Last year, the poison was placed around in small piles among apiaries of 38 stands of bees and the honey systematically, taken from the stands. This usually makes bees more active in feeding. Even under these conditions, but a single bee was observed feeding on the mash. These attempts at feeding the poison bran mash to the bees were repeated morning, noon and night, and no evidences were observed which would tend to show that there was any appreciable danger to the bees from the distribution of this poison.

Furthermore, against the insects for which this poison is used, it is most effective when scattered early in the morning or late in the evening. Before the working hours of the bees began, the poison would, then, be too dry for them to feed upon.

From this it would appear that when the poison mash confronts the bees, they will partake of it and perish; but, that the use of the mash in field work is not attended by danger to bees.

Another common inquiry is the effect of this poison upon chickens. One series of experiments carried on in a ten-acre truck patch, composed of onions, rhubarb, asparagus, sweet-potatoes and tomatoes, will serve as an answer. This plot, located in Gray county, near Cimmeron, attracted grasshoppers from all the adjoining fields. The poison bran mash was scattered over this patch two or three times every week, in order to kill the hoppers as fast as they came in. The owner likewise used his chickens, about 500 in number. These were distributed in coops over the whole garden every morning, and no chickens, whether large or small, were poisoned.

There seemed to be some evidence, however, to show that turkeys are likely to be poisoned; due, probably, to their habit of eating large quantities of the dead and dying poisoned grasshoppers.

Further experiments will be necessary before we can speak conclusively upon this point.

Army Worms

The past season there were a number of local outbreaks of Army worms. The most effective means found for their extermination was the liberal use of the bran mash poison, scattered in the evening. The worms will often leave garden vegetation for the poison, and in our experiments, they were frequently observed turning back in their course to get this poison.

By actual yard-square counts, one application, in some instances, destroyed 90 per cent. of the worms. Death usually ensued about one hour after the feeding had begun.

Intermittent Seasonal Spraying

Among our commercial orchardists, it is universally accepted that intelligent spraying is necessary to profitable returns. Among the smaller orchardists, however, the question frequently arises regarding the necessity for annual spraying. That is, sometimes there is a notion that in an orchard where injurious insects and plant diseases have been well controlled for some years, an intermission of one year's time succeeding such spraying would not permit such enemies of the apple to become sufficiently prevalent to materially affect the crop. Last season an unusually good opportunity was offered to secure a practical answer to this question. That is, to determine what beneficial effects, if any, would accrue to an orchard this year, from three years' proper spraying prior to the present one. In other words, to determine whether an orchard, successfully sprayed for three years, could be profitably permitted to go unsprayed this year.

The orchard selected was a ten-acre orchard of commercial varieties which had been successfully sprayed for the three years past. Last year, and the year before, this orchard showed less than 5 per cent injury due to injurious insects and plant diseases. In this ten-acre orchard this year, two representative trees for each of the following varieties were chosen: Ben Davis, Gano, Jonathan, Black Twig, Missouri Pippin, Wine Sap and Willow Twig. The set of the fruit on these trees compared very favorably with that of the three previous years. Monthly counts, beginning with the first week in each month of the months of June, July, August and September were made of the drops from these trees, to determine the cause of the fall of the apples.

This was the same system that had been followed for the three previous years. These apples were scored and tabulated under the various injurious insects and plant diseases common to the apple. Of the entire 26,244 collected throughout the entire season, there were 218, or 1.5 per cent sound apples. The remaining 98.5 per cent had been checked in their growth and development by an injurious insect or plant disease, or by the two combined. Of those which dropped prematurely, the small percentage of sound apples might have their fall attributed to the wind.

The accompanying table illustrates this work in detail.

SUMMARY OF APPLE COUNTS OF INTERMITTENT SEASONAL SPRAYING

	June 9 and 10	July 8 and 9	Aug. 4 and 5	Sept. 2 and 3	Per cent.
Codling moth	1,526	1,845	2,940	2, 659	46.3
Codling moth and bitter rot		274	945	3, 346	23.9
Codling moth, bitter rot and curculio		3	152	556	3.6
Codling moth and blotch		12	508	450	4.9
Codling moth and curculio		18	755	1,296	10.6
Codling moth, blotch and curculio			53	12	.34
Curculio	496	60	100	259	4.63
Curculio and bitter rot		8	55	5	.34
Blotch			15	307	1.64
Blotch and curculio			38	240	1.42
Railroad worm		5	30		.15
Bitter rot		13	16	11	.20
Scab		7	5		.04
Codling moth and railroad worm			13		.06
Sound apples		218	30	42	1.5
Thinning drop	6,833				
Codling moth and scab		47			.24
Codling moth, bitter rot and blotch				32	.12
Total	8,855	2,510	5,628	9,251	100%
Sum total			26,244		

The question naturally arises, "What of the marketable apples"? Referring back to the last year's record for these same varieties, the smallest average yield per tree was one and one-half barrels of sound marketable fruit, in size, two and one-half inches, or better. This year, from these same trees, the number of apples still remaining at picking time averaged thirty-five to the tree, most of which were below market size. Obviously, no count or tabulation of these would serve any purpose. The climatic conditions this year were better than the two previous years; the only features absent this year were spraying and cultivation.

The above condition represents the situation in this orchard at

picking time. The loss was greater than might reasonably have been expected. The orchard is remote from any unsprayed orchard and the ground was left last season practically free from apples.

The conclusion, naturally, is that the orchardist can no more reasonably expect an apple crop without intelligent cultivation and spraying than can the farmer expect a corn crop without proper and intelligent planting and cultivation.

President H. T. Fernald: The next paper will be read by Mr. H. A. Surface.

EFFICIENCY OF PARASITES OF THE SAN JOSÉ SCALE

By H. A. Surface, *Harrisburg, Pa.*

(*Withdrawn for publication elsewhere*)

Mr. Francis Windle: Through my inspections several years ago I noticed the operations of some predacious insects, as well as parasites, upon the San José scale, and when inspecting in Adams County, probably a year ago, it was a very difficult matter to find any live San José scale, although there was evidence of many trees that had never been sprayed having been badly infested. Two or three years previous to this I had reported the operations of parasites on the scale in my own county of Chester, and noticed the gradual disappearance of the scale. Not only in Adams and Chester Counties, but in Bucks and Berks Counties, I found the same conditions.

Mr. D. G. Tower: About a year ago while collecting parasites of the native scales at Amherst, this parasite was found in abundance. Dr. L. O. Howard kindly determined it as a new species and accordingly a description was published. Since then notes on its life history have also been published. Dr. Fernald announced that no hyperparasites had been found at Amherst and stated that parasites would be sent to those desiring them. I am inclined to think that hyperparasitism, if such is the case, will not greatly hinder the work of this parasite. Professor Parrott has shown that this parasite is the dominant one in New York. While I do not expect to see the scale cleaned up in a single case by this parasite, still in unsprayed or in orchards impracticable to spray, on ornamental shrubs and in forests, I think the work of this parasite will be of considerable value.

Secretary A. F. Burgess: I would like to say a word in connection with the acceptance, without a great deal of consideration, of statements made by the average fruit-grower or person who is not a specialist in parasitic work on the results of introducing parasites. We have had considerable experience along this line on the gipsy and brown-tail moth work in New England, and we find that a great many people who know these pests thoroughly do not understand about the parasitic species introduced or the results that may be expected. They anticipate quick and immediate results whenever parasites are liberated, and if there is a decrease in numbers of the pests concerned, they immediately attribute this to colonization of parasites.

I am not speaking in regard to the parasites of the San José scale because we have had no experience with these but we are satisfied that the average farmer and fruit-grower, or other man, who has infested trees, is very apt to lay too much stress on the colonization of a parasite in his orchard or woodland if there is any decrease in the severity of the infestation.

Mr. W. E. Britton: Perhaps Mr. Tower or someone else can give us an idea of the natural distribution of the parasites under consideration.

Mr. D. G. Tower: I have found the parasite in numerous places in Massachusetts and on the Capitol grounds at Washington, D. C. Specimens have been sent to me from Connecticut by Dr. Britton and from New York by Dr. Felt and Professor Parrott. Professor Surface has found it in many places in Pennsylvania. Specimens have been sent to Dr. Forbes in Illinois to start a colony there and I have attempted to start one at Lafayette, Indiana. Whether this last has been successful or not cannot be stated at this time. It is my opinion that in order to secure accurate data on the amount of parasitism, the scales should be examined for eggs, larvæ and pupæ of the parasite as well as a count of the exit holes made. The percentage of parasitism of the scales examined at Amherst would average, I think, from 75 to 85 per cent and it was evident that the parasite was doing good work. As regards the life-cycle of the parasite, it apparently coincides with that of the scale, in the majority of cases emerging from mature second stage female scales, The reason for some emerging from immature third stage female scales I have endeavored to explain in my recent paper.

President H. T. Fernald: The next paper will be read by Mr. C. L. Metcalf.

A MECHANICAL MEASURE FOR CONTROLLING THE FLEA-BEETLE (EPITRIX FUSCULA) ON POTATO.[1]

By C. L. Metcalf, *Ohio State University, Columbus, Ohio*

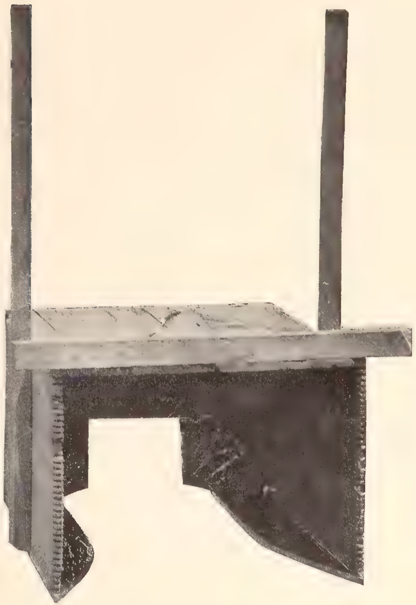
The difficulty of controlling flea-beetles with the known insecticides is generally appreciated. In North Carolina we tried a variety of materials without finding any really satisfactory insecticide. This fact and the well-known habit of these insects of jumping vigorously at the slightest disturbance, suggested to the writer that their economic control might be achieved by some method of trapping.

In 1913 a crude trap (Pl. 10, fig. 1) was improvised from a store box by cutting out one end, a part of the bottom and of the other end. The inside was covered with a thin coat of tree tanglefoot; and the box carried along the rows by the upright handles, so that the vines passed through the box from one end to the other. After covering one-fortieth of an acre of potatoes, moderately infested, a count showed 370 flea-beetles entangled in the trap. After covering one-fifth of an acre in the same way, 2,335 flea-beetles were counted in the tanglefoot. This was disposing of flea-beetles at the rate of 10,000 to 15,000 per acre, as rapidly as two men could walk along the rows.

A modification of the handle of the box so that one man could manipulate it was the most needed improvement. It was noticed at once that most of the beetles were caught on the lower part of the box, especially on the pieces (Pl. 10 fig. 2, A, A). It is, therefore, desirable to have these pieces extend inward as far as possible. It was also considered of some advantage to have a box wider in front than behind so that it might surround the vines before the insects became much disturbed. The opening at the rear (Pl. 10, fig. 2 B,) should be small to thoroughly disturb the vines as they pass. Two and a half to three feet seemed to be the best length for the box, while it should be just high enough and wide enough to cover the plants.

The leaves from the plants accumulated on the sides and back of the box; so a system of wires was devised running from the front to the opening at the rear. (See Plate 10, fig. 2). This effectually prevented the leaves from touching the sticky surface without affecting the efficiency of the trap. In order to facilitate the renewal of the tanglefoot surface, the wires were fastened in front to three wooden strips (Pl. 10, fig. 2, C, C, C) which in turn were attached to the box with thumb screws and so could easily be removed. It is believed to be essential for the highest efficiency that the trap precede the operator so that there is no disturbance of the vines until they are covered by the box.

[1] This work was carried on under the direction of Mr. Franklin Sherman, Jr., State Entomologist, Raleigh, N. C., to whom I am indebted for permission to publish it.



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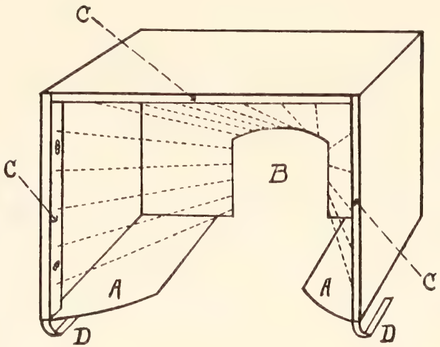

Fig. 2.

Fig. 3.

Flea Beetle Collector

With these points in mind a trap was devised in 1914 to run on light wheels (Pl. 10, fig. 3) in order to reduce the labor to a minimum. A pair of light springs should be fastened to the front of the box (Pl. 10, fig. 2, D, D) to prevent it from dipping into the soil, since otherwise a portion of the tanglefoot soon becomes covered with dust. This arrangement works nicely on even ground; but carrying the trap will probably be found to be more efficient. A count of the number of beetles caught by this trap showed 1,357 as a result of covering one-twentieth acre, which is at the rate of over 25,000 per acre.[1]

The expense involved in the use of such a trap should be moderate. A simple trap can be made by anyone in a few minutes. It is largely a matter of adapting the box to the size of the plants to be treated. When the sticky surface becomes matted over it may be renewed a time or two by scratching it with a wire comb or brush. Warming the tanglefoot made it easier to apply a thin even coat.

The ordinary routine spraying of potatoes will control the flea-beetles to some extent. However, from these preliminary experiments the apparatus described is believed to have a place in cases of severe infestation; and in caring for small areas of various garden crops which are attacked by one or another species of flea-beetle.

Mr. T. J. Headlee: I would like to know whether these experiments have been tried on a large scale throughout the season for the purpose of determining whether potatoes can be protected in this way?

Mr. C. L. Metcalf: We had in mind to do this but the infestation of flea-beetles in North Carolina was 250 miles from our headquarters, and we found it absolutely impossible to use this trap at frequent intervals throughout the season. I am therefore unable to say but I see no reason why it might not.

Vice-President Glenn W. Herrick: How often did the trap have to be coated inside?

Mr. C. L. Metcalf: That would vary greatly with conditions. We could cover as much as half an acre or an acre and then by scratching the surface slightly go on for a quarter of an acre farther perhaps. It would need to be removed altogether from five to perhaps ten or a dozen times in the course of a day.

President H. T. Fernald: If there is no further discussion, we will now adjourn.

Session adjourned at 5.30 p. m.

[1]Incidentally a species of leaf-hopper (*Empoasca mali*) was taken at the rate of about 40,000 per acre.

Morning Session, Thursday, December 31, 1914, 9.00 a. m.

President H. T. Fernald: The first paper on the program will be by Mr. J. M. Aldrich.

THE ECONOMIC RELATIONS OF THE SARCOPHAGIDÆ

By J. M. Aldrich, *Assistant in Cereal and Forage Insect Investigations, Bureau of Entomology*

The classification of this family has been until within a few years in a very unsatisfactory condition throughout the world. However, the study of the male genitalia has recently solved the problem in Europe, and in that region the species of Sarcophaga are perhaps more satisfactorily distinguished now than those of any other large Muscoid group, although there is still much uncertainty as to where the limits of the group lie. Mr. Parker's work on the American species, beginning about two years ago, and my own beginning last winter, have shown conclusively that the North American species yield to the same treatment; while as yet we have no specific names for many of the forms, it will be only a matter of a year or so until this will be remedied. Meanwhile I wish to call attention to the larval habits of a considerable number of bred species which have passed through my hands for identification.

The notion that Sarcophagidæ are "flesh-flies" is derived from Linnæus and his predecessors, and is no doubt true as to the typical species *carnaria* in Europe; but it is very misleading in our fauna. Herms bred *S. assidua* and *sarraceniæ* from dead fish on the beach of Lake Erie, and I have collected adults of the latter on dead fish on the beach of Lake Michigan; Parker's new *cooleyi* feeds on dead fish in Montana; I have also noted adults of another species on dead snails along the banks of the lower Wabash River in Indiana. There is also the classical case of the larvæ of *S. sarraceniæ*, bred by Riley from the contents of the cups of *Sarracenia variolaris*. Several records of feeding in decomposing flesh of the warm-blooded animals, not yet published were communicated to me very recently, but the principal ones are from the far south (Texas).

The excrement of mammals furnishes a breeding-place for a considerable series of species: *S. assidua, cooleyi, hæmorrhoidalis, trivialis, incerta* and *lambens*, and *Ravinia communis, latisetosa, peniculata, quadrisetosa* and *trivialis* seem to be rather closely restricted to this breeding habit; *S. sarraceniæ* and *helicis*, which have also been reported, have other more common habits.

Parasitism on other Arthropods includes by far the largest part of

the records accumulated up to the present, and many of them are of considerable interest. Schiner in his Fauna Austriaca expressed a doubt whether the few recorded cases of his day might not be explained as carrion-feeding, the insects having died before the eggs of the fly were laid; and his doubt has curiously persisted and found frequent expression almost to the present time. But the large number and variety of the cases now known, many of them closely studied, permit no further doubt that Sarcophagas are generally parasitic in their habits. At least this is true with many of the species.

There are two records of rearing from scorpions, one from Sumatra of an undetermined species, the other *S. sternodontis* from one in Jamaica.

Egg-sacs of spiders furnish a nidus for *davidsonii*, reported only from California.

The adult of *Corydalis cornuta* has been attacked by *Sarcophaga helicis*, a series of bred flies with data being in the National Museum collection, dating from Riley's time.

Grasshoppers have furnished a large amount of bred material in several species: *S. helicis*, *hunteri*, *sarraceniæ*, *kellyi*, and the species heretofore erroneously known as *cimbicis*, are the ones most frequently bred in the West; of these *kellyi* is undoubtedly the commonest one. Mr. E. O. G. Kelly, in the *Journal of Agricultural Research* for September 21, 1914, has described its egg-laying habit. The female darts at the flying grasshopper and strikes it with enough force so that it instantly drops to the ground, when the larva of the fly can be found attached by a gluey secretion to the thorax or base of the wing. The fly also deposits larvæ on the quiescent, newly-moulted adult hopper while it is hardening, this involving an instinct-stimulus quite different from the other case.

A western species closely allied with *erythrura* of Europe has been found abundantly about grasshoppers in Colorado; the female fly has a fairly well-developed larvipositor, and presumably inserts its young under the body wall of the hopper, though this has not been observed. There is every reason to believe that in the arid west grasshoppers are normally kept within moderate numbers principally through the agency of the Sarcophagid parasites. In the east these are not so frequently reared; *sinuata*, *sarraceniæ* and *helicis* have been reported.

A specimen of *Cicada tibicen* was sent in to the Bureau of Entomology in August, 1894, from Waterfield, Va.; it was dead when received, and a number of dipterous larvæ had emerged, from which subsequently developed the ubiquitous *S. helicis*.

The question whether Sarcophagids are anything more than scaven-

gers in relation to lepidopterous larvæ and pupæ is discussed by Howard and Fiske, Bull. 91, Bur. Ent., 1911, p. 250, where it is stated that in imported gypsy moth material there have often been more Sarcophagid than tachinid puparia; notwithstanding this fact, absolute proof that the Sarcophagid larvæ invade living caterpillars is said to be lacking. The same conclusion was reached by Patterson (in Bull. 19. Tech. ser., Bur. Ent., part 3, 1911) as far as the Gipsy Moth is concerned; but he did not distinguish species at all in his experiments, hence may have been using the common excrement-feeding *Ravinia communis* when he attempted without success to induce the flies to larviposit on living caterpillars. I can supply the missing proof in one instance:—living larvæ of the Army Worm moth were brought into the Bureau insectary at Lafayette last summer by Mr. J. J. Davis and assistants, confined in breeding cages, and yielded 30 or more adults of *Sarcophaga helicis*—more of these than of any Tachinid parasites. Since the Sarcophagids have been seen to larviposit on living grasshoppers, and as I shall show farther on, also upon living beetles, it becomes easier to admit that they parasitize caterpillars. The records include undetermined Sarcophagas attacking *Alabama argillacea*, *Acronycta ovata*, and *Phakellura hyalinitalis*; *S. helicis* on *Loxostege sticticalis*, *Pieris* and the Army Worm; *hunteri* on Army worm, and even the Codling Moth; and *amblycoryphæ* on *Amblycorypha oblongifolia.*

The only record relating to Hymenoptera that I have found is that of *Sarcophaga* (*Bœttcheria*) *cimbicis* Townsend, of which the types were bred from larvæ of *Cimbex americana.* Other published records for *cimbicis* are all due to misidentification, as I lately learned from an examination of the types; the species has been bred only once.

Sarcophagas have been bred several times from beetles, usually from the adults.

On May 13, 1893, 34 adults of *Lachnosterna arcuata* were collected in Washington and placed in a breeding cage. From these there emerged several specimens of *S. helicis*, which matured in July.

On March 4, there were received in the Bureau living larvæ of the beetle, *Dinapate wrightii*, in a piece of palm trunk from Southern California, sent in by H. G. Hubbard. Two adult beetles emerged in July and August, and on September 2 there came out of one of these adults several dipterous larvæ, which gave *S. helicis* on September 11.

On September 13, 1894, two specimens of the same fly issued in a jar which had contained larvæ of *Calosoma* sp.

In the summer of 1914, Mr. D. E. Fink, of the Bureau of Entomology, bred *S. sarraceniæ, helicis,* and a new species, from *Allorhina*

nitida—the first from a pupa, the last two from adults. This was at Norfolk, Va.

On August 16, 1914, Mr. W. R. Walton, of the Bureau of Entomology, near Cimarron, N. M., captured a female Sarcophaga in the act of larvipositing on the body of an adult living specimen of *Eleodes hispilabris*. In September of the same season, at Koehler, N. M., Professor H. F. Wickham reared several specimens of the same fly from adults of *Eleodes tricostata* and *obsoleta*. In reply to an inquiry as to the possibility of the fly larvipositing only on dead beetles, Professor Wickham wrote: "There is no doubt that all of the Eleodes of mine from which Sarcophaga larvæ were secured had already been infested before being placed in the cages in which the food experiments were carried on. These cages were all closed with wire screen over the tops, the cages themselves being of the battery jar type. In most of them the top had been made of wood with a central circular opening which was covered with the wire mesh. . . . My practise was to take an Eleodes out of the cage as soon as it was noticed to be dead and place it in a vial covered with fine cheesecloth. Sometimes the larva left the beetle within an hour or less, at other times it remained for several weeks. In no case has a beetle been left where it could have been 'blown' by a free fly."

How the larva of Sarcophaga manages to penetrate the armor of an adult Eleodes has not been ascertained.

In November, 1914, at the University of Kansas, Mr. H. B. Hungerford showed me specimens of an undescribed species of Sarcophaga, which he had bred from adults of the longicorn Cottonwood Borer, *Plectrodera scalator*, at Kinsley, Edwards Co., Kansas; the flies were numerous, affecting 90 per cent of the beetles.

A few scattering records may be added.

Human beings are occasionally affected, but in various ways: one instance of intestinal myiasis, one of nasal, one larva in the ear, and one in a tumor on the back, are on record in this country. None of the species have been identified except the one in the intestine, which was *Ravinia trivialis*, normally an excrement-feeding form.

Sarcophaga helicis, as the name implies, was originally bred from a snail.

Undetermined species have several times been bred from tumors on the neck of tortoises.

Cole bred two undetermined species from rotting kelp on the seashore at Laguna, Cal. (Pom. Coll. Jour. Ent., iv, 840).

Only a few of the species so far have shown a wide range of adaptability in larval habit; but this may very likely be a conclusion from too few cases. *Helicis* has been bred from a snail, Corydalis, Cicada,

several Lepidopterous larvæ, several adult beetles, several grass hoppers and a Mantis, and according to one record from cow manure, though I am skeptical about this. *Sarraceniæ* without doubt breeds at times in dead fish and is at other times a parasite of insects; it has even been recorded from human excrement, but this might have been a misidentification.

We seem to be dealing with a group in which the parasitic habit is just being formed, and is still much more plastic than is the case with Tachinidæ, connecting the latter with the true Muscids—just where, by good luck, we happen to have placed them in our lists.

Mr. R. R. Parker: I would like to add a few words to what Dr. Aldrich has said, and shall deal mainly with their excreta-frequenting habits. My data are based principally on personal observations made during the past summer while carrying on investigations for the Montana State Board of Entomology, undertaken in part to determine what Montana flies may be considered of actual or potential importance as disease agents or as carriers of disease.

In one experiment in which a trap was attached to the back of a privy with a sunken vault so as to catch the flies which had visited the excreta, 43 Sarcophagids were captured in one month, about 0.5 per cent of the total catch, and these were principally *Sarcophaga cooleyi* R. Pkr., a species not known to breed in excreta.

Of flies captured with excreta as bait, Sarcophagids constituted 8.75 per cent of the catch in seven experiments. Of these, *Ravinia communis* R. Pkr. was the most numerous and specimens of *R. peniculata* R. Pkr., *Sarcophaga hæmorrhoidalis* Meig. and *S. cooleyi* R. Pkr. were also taken. All were females except a few specimens of *S. hæmorrhoidalis*. It is interesting to note that the great majority of oviparous species were also females.

Of flies noted in houses no proportionate record was kept, but specimens of *Ravinia communis* R. Pkr., *R. peniculata* R. Pkr., *Sarcophaga hæmorrhoidalis* Meig. and *S. cooleyi* R. Pkr. were either captured or observed, though only occasionally. Under certain conditions, such as those prevailing in construction camps, it is probable that a larger proportion of these flies would be found frequenting food, than under town or city conditions.

The most interesting results were obtained from breeding experiments. From material taken from privies with sunken vaults no Sarcophagids were reared, but only oviparous species, mainly *Ophyra leucostoma* Weid., and species of *Fannia*, *Limosina* and *Scatopse*. On the other hand, when dealing with material exposed in the open,

Sarcophagids were reared almost to the exclusion of oviparous forms, the latter consisting principally of *Muscina stabulans* (Fall). While the number of experiments was too limited to permit of definite conclusions, they did indicate that where surface excreta and that from surface privies was concerned, the Sarcophagids apparently prevented the oviparous species from breeding in any great numbers. This may be due to the Sarcophagid larvæ preying upon the others, or they may be more successful in the struggle for food; at least they have the advantage of being deposited as larvæ. I would not care to suggest that this relationship would hold farther south where there are more oviparous forms which breed in excreta. As Sarcophagids are less numerous and less commonly found in houses than oviparous species that frequent excreta, they may perhaps be considered beneficial in so far as the relationship suggested above holds good. In one experiment, 970 Sarcophagids were reared from a single stool which was found in a back alley and had been exposed one day; 944 of these were *Ravinia peniculata* R. Pkr. *Sarcophaga tuberosa sarraceniæ* (Riley) was bred from fish, but was not found in excreta though supposed to frequent it abundantly. *S. cooleyi* R. Pkr. was bred in large numbers from fish, and also from the carcass of a kitten.

The species of *Ravinia* are probably primarily breeders in excrementous substances, and when excreta is deposited in the open are commonly the first flies to be found on it. *Ravinia communis* R. Pkr. was bred from human excrement, cow dung, horse manure, hen manure and pig manure; *R. peniculata* R. Pkr. from human excrement and cow and pig manure; several other species, some undescribed, are also known to breed in manures of various kinds. There are very few records of these species under other conditions. I also have records of excreta-frequenting habits for several undescribed species of *Sarcophaga*. These flies also frequent garbage to some extent as it is found exposed in the vicinity of stores and residences.

President H. T. Fernald: I suppose all economic entomologists fully appreciate the necessary foundation of systematic work upon which their studies must rest. It has been of interest to me in examining collections throughout the country, as I have had the opportunity, to note the number of Sarcophagidæ labeled "Sarcophaga sp."

I think we are to be congratulated on the fact that since Mr. Aldrich, Mr. Parker and others have been doing so much work along this line, this unsatisfactory condition promises shortly to be removed and that economic studies of the Sarcophagidæ may apply to the particular species concerned in each case.

President H. T. Fernald: The next paper on the program will be by Mr. J. W. McColloch.

FURTHER DATA ON THE LIFE ECONOMY OF THE CHINCH BUG EGG PARASITE

By J. W. McColloch, *Assistant Entomologist*, and H. Yuasa, *Assistant in Life History Studies, Kansas Agricultural Experiment Station*

At the annual meeting of this association last year the writers presented a paper on "A New Parasite of the Chinch Bug Egg, *Eumicrosoma benefica* Gahan." This paper was a preliminary report based on the first year's study and consequently the results were subject to some modification as the work progressed.

As the habits of the insect under consideration became better understood and the technique of rearing and handling developed, more accurate results were obtained. Owing to many unforeseen circumstances which arose during the first year's work, the study of the life history suffered several reversals and a complete life history was not worked out. During the past summer these circumstances were anticipated and a continuous life history study was made. By the development of certain methods of technique it was also possible to observe the growth of the various stages within the host egg and to dissect out the different stages for a more detailed study.

During the past summer about 4,500 parasites were reared and a large amount of data was collected. While most of the results coördinate those obtained in 1913, some of them show considerable variation. As the work of this year was carried on under more improved methods, which conform more nearly with the natural habits of this insect, it would seem that the results are more typical of the life of this parasite under natural conditions.

History and Distribution

The history of *Eumicrosoma benefica* began in May, 1913, when it was found parasitizing chinch bug eggs in the vicinity of Manhattan, Kansas. During the summer of that year it was taken in sixteen counties in Kansas comprising most of the area of chinch bug infestation. Five counties have been added to this list during the past summer, namely, Finney, Sedgwick, Butler, Elk, and Miami.

Mr. W. B. Flint, assistant state entomologist of Illinois, reports finding parasites in limited numbers in a few localities in that state. It is probable that the parasite is also present in Oklahoma and Missouri, as it has been taken many times in Kansas within a few miles of the borders of these states.

Importance

From the data thus far accumulated the egg parasite is an important factor in the control of the chinch bug. In the spring of 1913 the emergence of chinch bugs from winter quarters was one of the largest ever witnessed in Kansas and the indications were for serious injury during the ensuing summer. Within two weeks after this emergence the wheat fields were beginning to show considerable damage and a few fields were entirely destroyed. Hundreds of eggs were deposited around nearly every wheat plant and it was thought that the wheat and corn fields in many localities would be practically a total loss. In two or three weeks it was evident that a large percentage of the eggs were not hatching as the number of young bugs was far below the expectation. At harvest when the bugs migrated to the corn fields there was very little complaint of injury and throughout August the number of bugs in the corn was exceptionally low. In the fall of 1913 the counts of the number of bugs in winter quarters showed only one bug where there were from twenty-five to one hundred in the fall of 1912.

The climatic conditions during 1913 were favorable for the development of the chinch bug. The drought during the summer prevented the development of the chinch bug fungus and there was no known factor except the parasite which could have caused this great reduction. In Illinois, where practically the same conditions existed as in Kansas, with the exception that there were few parasites present, the chinch bugs did a vast amount of damage in 1913 and were equally bad in 1914.

In 1913 the average parasitism at Manhattan during the summer was 32 per cent and during the spring when chinch bugs were most numerous it ranged from 20 to 40 per cent. In the experimental work it was shown that the period of oviposition of the chinch bug covered about two months, while the life cycle of the parasite extended over a period of only two or three weeks. Thus the eggs of a single female chinch bug were exposed to about three broods of parasites while the eggs of one brood of chinch bugs were exposed to four or five broods of parasites. From this data it is conservative to estimate the parasitism in the field during 1913 to have been at least 50 per cent.

The number of chinch bugs in the fields about Manhattan in 1914 was exceptionally small and there was a marked reduction in the number of parasites. The parasitism in the early spring was considerably below one per cent, but as the summer progressed it gradually increased until in September it reached 25 per cent. Table I gives the percentage of parasitism by months at Manhattan.

Table 1. Showing the Average Percentage of Parasitism at Manhattan, Kansas, in 1914

Month	*No. of Eggs*	*Per Cent of Parasitism*
May	3,002	0.16
June	1,204	5.2
July	4,989	6.3
August	1,777	9.0
September	28	25.0

Collections of eggs were made in sixteen localities in the state during July and August and the average parasitism for the state exclusive of Manhattan was 14.5 per cent.

The Egg

Description.—Fully developed eggs were readily dissected from the abdomen of the adult female and in a number of instances eggs were dissected from the host egg soon after oviposition. The egg (Fig. 11, A) is ovate in shape and tapers into a long stalk at one end. The opposite end tapers gradually and ends in a blunt point. The stalk is about two-fifths of the entire length of the egg and the micropyle is located at its tip. The comparatively large nucleus is located near the blunt end. The egg is 0.23 mm. in length and 0.07 mm. in width.

Development.—Shortly after deposition the egg begins to swell due to embryonic development. In one instance an egg was removed four hours after deposition. It had increased in volume, had become spherical in shape and the protoplasmic content had begun to appear differentiated but had not developed sufficiently to show any definite form.

Length of Egg Stage.—The length of the egg stage was determined in a number of cases and was found to vary from a few hours to about one day. During midsummer eggs deposited about 6.00 p.m. hatched before 7.00 the following morning.

The Larva

Description.—In the life history two distinct larval stages were found. The first stage (Fig. 11, B) resembles closely the first larval stage of Teleas as described by Ganin.[1] The larva when first hatched is about one-fifth the size of the host egg. It is supplied with a large pair of mandibles which are strongly chitinized and each bears a sharp claw at the outer extremity. The caudal extremity ends in a long tail-like process which is about one-half of the length of the body. No segmentation was distinguished but there is a marked constriction between the head and the body region.

[1] Ganin, M., 1869. Beiträge zur Erkenntniss der Entwickelungsgeschichte bei den Insekten. Zeits. wiss. Zool., bd. 19, pp. 381–451, 4 taf.

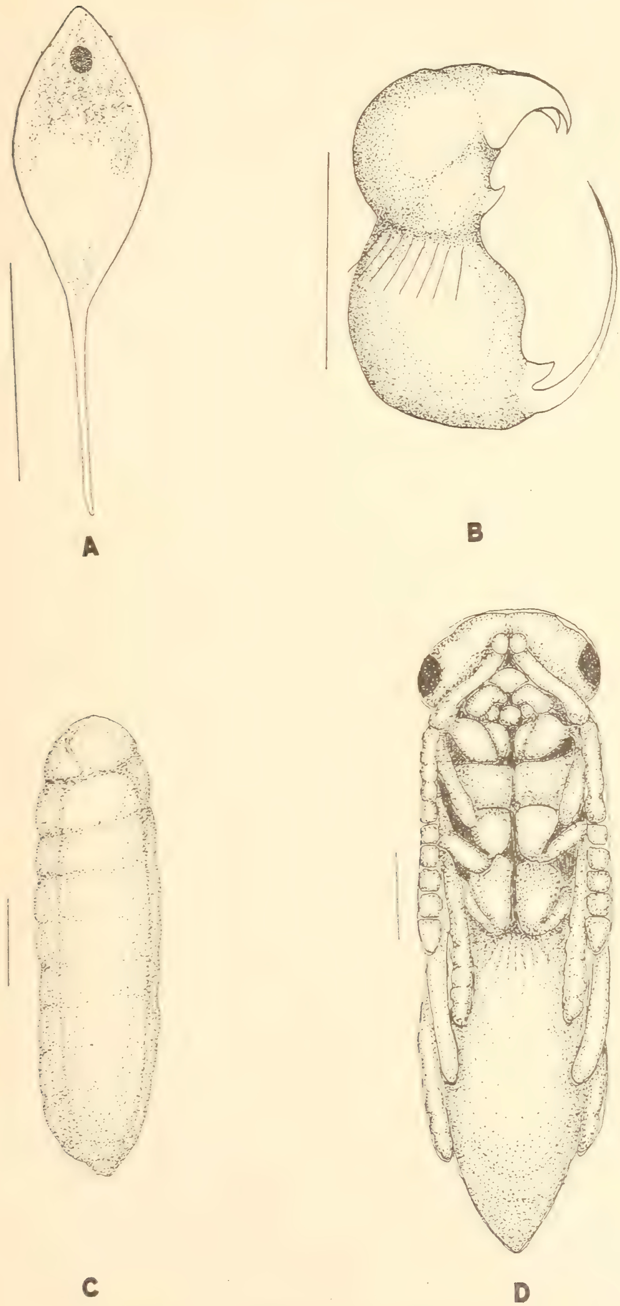

Fig. 11 — Different stages of *Eumicrosoma benefica* Gahan. (*A*) Egg. (*B*) First stage larva. (*C*) Second stage larva. (*D*) Pupa. All greatly enlarged, the hairline being $^1/_{10}$ mm. magnified to the same scale as the object. (Original.)

The larva is capable of moving from place to place within the host egg, locomotion being effected by the lashing of the tail and to some extent by the action of the mandibles. During the early part of its life the larva is very active and by the continual working of the tail and mandibles the contents of the host egg are disorganized.

The first stage larva feeds by a series of sucking motions by which the food is drawn in through the mouth into the pharynx and from here into the stomach, which is nothing more than a blind sac. Here the food is rolled backward and forward by the movements of the larva and probably by the contraction of the body muscles.

The length of the first larval stage is about two or three days and during this time the larva increases to about twice the original size, most of the growth occurring in the body region.

At the end of the first stage, the larva, which has lost its external constriction and is ovate in shape, becomes inactive. Transformation takes place within the old skin, the body shrinking back from the old cuticula which has become thin and soon bursts near the cephalic end. The larva gradually moves out of the old skin and the moult is complete.

The second larval stage (Fig. 11, C) is ovate in shape and occupies about two-fifths of the host egg. The tail-like process of the preceding stage has disappeared and the mandibles have become greatly reduced in size. Segmentation of the body shows faintly and ten or eleven segments can be distinguished. Tracheation becomes apparent in this stage and four or five pairs of well developed spiracles are noticeable. This stage feeds in much the same manner as the first larval stage. The food is apparently sucked into the pharynx, passing through the oesophagus to the stomach where digestion occurs. The stomach is a blind sac and until just before pupation no excrement is voided. Digestion is facilitated by the constant churning of the food back and forth by the contractions of the muscles of the stomach. These contractions are somewhat regular in occurrence. They may start from either end of the body and move to the other end, they may start simultaneously from each end of the body and move to the center, or they may start at the center and run to each end. About three contractions start from the anterior end to one from the posterior and there are about two contractions per minute.

In about three days the larva has reached its full development and is ready to pupate. At this time all the contents of the chinch bug egg have been destroyed and the larva nearly fills the shell.

Length of Larval Stage.—It was possible to carry a number of larvæ through to pupation and thus the length of this period was determined. During August several larvæ were kept under constant obser-

vation. The first larval stage was completed in two or three days while the second larval stage required from three to four days. Another day or two was required for molting and for the excretion of waste. The total length of the larval stage varied from six to eight days.

The Pupa

Formation.—Just before pupation begins the larva ceases to feed and the waste matter which has accumulated within the body of the larva during its growth is deposited at the posterior end of the host egg. In a short time the body begins to constrict between the thorax and the abdomen. Subsequently the eye spots begin to appear. In a day or two the appendages begin to appear and pigmentation becomes apparent in the head, thorax, and body (Fig. 11, D). The transformation is completed in about eleven days and the adult emerges shortly after.

Length of Stage.—The pupal stage covers about three-fourths of the length of the life cycle. During August and early September a number of pupæ under constant observation required from eleven to thirteen days to complete this stage.

The Adult

Description.—The adult form (Figure 12) was described last year by Mr. A. B. Gahan,[1] entomological assistant of the United States Bureau of Entomology and his description was given in the previous paper.

Fig. 12—*Eumicrosoma benefica;* adult. Greatly enlarged (After Gahan).

During the past summer a melanic form was reared in the fourth generation which differed from the form described by Mr. Gahan in that the entire body was black. By crossing with the normal form it was possible to carry this form through the remaining generations. During this time eighty-six black females and sixty black males were reared. On August 19 a black male was reared from a chinch bug egg collected in the field.

[1] Gahan, A. B., 1914. New Hymenoptera from North America. Proc. U. S. Nat. Mus., Vol. 46, pp. 442–43.

Time of Emergence.—Considerable data was collected on the time of emergence of the adult parasite. During the life history study all material was examined at 8.00 a. m. and 5.00 p. m. each day for the emergence of parasites. In this way it was found that the optimum time for emergence was between 5.00 p. m. and 8.00 a. m. Of the 4,474 parasites bred during the season, 4,136 parasites, or 92 per cent, emerged during the night, while 342, or 8 per cent, emerged during the day. In order to determine the exact time of emergence 309 parasitized eggs were kept under hourly observation from July 31 to August 12. Two hundred and seventy-six, or 88 per cent of these parasites, emerged between the hours of 6.00 a. m. and 9.00 a. m., the maximum emergence occurring between 6.00 and 7.00.

Period of Emergence.—The emergence from parasite eggs laid on the same day may extend over a period of from three to fifteen days. During the summer months this period varied from three to six days, the maximum emergence occurring the second or third day. In the fall this period was prolonged to from eleven to fifteen days.

Relation and Economy of Sexes.—In a number of experiments conducted to determine the relation and economy of sexes, it was found that one male could fertilize as many as ten females and that one female could mate with as many as six males. It was also found that when oviposition occurred without mating all of the offspring were males. When mating occurred about 70 per cent of the offspring were females. The factor that influenced the number of eggs parasitized per female was the number of eggs supplied. This factor also influenced the mortality of the parasites in the host egg. When few eggs were supplied double parasitism often resulted.

Method of Oviposition.—Oviposition was observed many times under laboratory conditions and in practically every case the process was the same. The female parasite, on finding an egg, hurriedly makes a preliminary survey of it by crawling over the egg and feeling it with her antennæ. Generally, the female in making this examination goes over the entire egg, the progress being along the long axis. If the egg does not suit she may discard it after this examination. If the preliminary survey proves satisfactory, a more careful survey is made in which the female goes over the egg slowly and examines every part of it carefully by tapping with the antennæ. If this examination proves all right the female crawls off the egg and with her back to it endeavors to find a suitable place for the insertion of the ovipositor. The latter is protruded until it touches the egg and then the female begins a survey by sounding various parts of the egg with the tip of the ovipositor. Often it is necessary for her to change position once or twice before a suitable place for its insertion is found. When a

place is found the actual insertion takes place. The parasite assumes a rigid position, the tip of the ovipositor touching the surface of the egg. The two pieces composing the sheath of the ovipositor are then pushed and withdrawn alternately for some time until a hole is made in the shell. The inner valve of the ovipositor, which is chitinized and sharp, is then suddently thrust into the egg. Oviposition immediately follows this procedure and is distinguishable by a slight swelling which starts at the base of the ovipositor and passes in a wave-like motion to its tip. Immediately following oviposition the inner valve of the ovipositor is withdrawn and at the same time the caudal segments of the abdomen are extended to the surface of the chinch bug egg and the ovipositor is then withdrawn.

The female may then walk away or she may endeavor to oviposit again in the same egg. The entire process of egg deposition may require from one to five minutes. The parasites do not seem able to distinguish parasitized eggs from normal ones. In the course of the season females were observed ovipositing in parasitized eggs, egg shells from which chinch bugs or parasites had emerged and eggs from which parasites were emerging. As many as three females were seen ovipoisting in the same egg at the same time. At no time was a female seen attempting to parasitize eggs other than those of the chinch bug.

Oviposition may occur at any time of the day or night. In the laboratory parasites were supplied with eggs at all hours and egg laying occurred soon after. Parasites confined in darkness were fully as prolific as those kept under normal conditions.

The period of oviposition may extend from two to eleven days, the maximum deposition usually occurring the first or second day.

Number of Eggs.—The number of eggs that a female could deposit was determined for about 300 individuals and was found to vary to a great degree. This variation was due to a number of factors, such as the number of chinch bug eggs supplied, the age of the eggs, food, fertilization, and age of the female.

Two hundred and twenty-six females parasitized an average of 16 chinch bug eggs or 53.5 per cent of the eggs supplied. The largest number of eggs deposited by a single female was 54 and this was by an unmated female. Seven females deposited over 40 eggs each and twenty-one females deposited over 30 eggs each.

Sixty females that had not been allowed to oviposit were dissected and the number of eggs in the ovaries counted. The largest number of eggs found was 36 and the lowest 5, while the average was 22.

Thirty-nine females that had been supplied regularly with chinch bug eggs were dissected after death and the average number of eggs remaining in the ovaries was 11.4 with extremes of 0 and 28.

Double Parasitism.—The female parasite does not seem to be able to distinguish between parasitized and unparasitized eggs and double parasitism often resulted. If double parasitism occurs at about the same time it results in the death of both larvæ, while they are in the first larval stage. If the second parasitism occurs when the first parasite is in the pupal stage, the second parasite makes no development and the first parasite emerges.

In the case of simultaneous double parasitism the eggs hatch in about the normal length of time but the resulting larvæ develop slowly and never reach the second larval stage. These larvæ may live from nine to twelve days, usually one of them dying two or three days before the other.

Parthenogenesis.—*Eumicrosoma benefica* can reproduce parthenogenetically but the percentage of eggs parasitized and the number of eggs parasitized per female is usually low. Twenty-three unfertilized females were supplied with eggs in the life history work. Of the 620 eggs supplied 239, or 38.5 per cent, were parasitized, an average of ten eggs per female. Two hundred and seven parasites were reared and 206 were males.

Proportion of Sexes.—In the study this year the number of females greatly exceeded the number of males. Of the 4,474 parasites reared during the past summer 3,176, or 71 per cent, were females, while 1,297, or 29 per cent, were males. Sexual reproduction, however, seems to be the rule, for of the 468 parasites bred from eggs collected in the field, 336 were females and 132 were males. In the laboratory studies unmated females always produced males.

Effect of Oviposition in Different Stages of the Host Egg.—The parasites show a decided preference for chinch bug eggs that are from one to three days old and the best results were obtained in laboratory studies when eggs of this age were used. A number of experiments were conducted in which parasites were supplied with eggs ranging in age from two to fourteen days. Parasitism occurred in all of these eggs but the percentage of parasitism decreased as the age increased.

Host Relations.—Numerous experiments were conducted again this year in an effort to rear *Eumicrosoma benefica* on some host other than chinch bug eggs but all proved negative. The parasites were supplied with eggs of *Nysius angustatus*, *Geocoris* sp., and of several species of Jassidæ. Large numbers of these eggs were also collected from grass containing parasitized chinch bug eggs and these were carefully examined for parasites but no evidence of parasitism by *Eumicrosoma benefica* was noted.

Length of Life.—The length of adult life was found to vary from a few hours to seventy-eight days. Temperature is probably the most

important factor which influences the length of life, and food is the next most important. During midsummer the average length of life was about four or five days, but with the advent of cool weather it increased to from 15 to 25 days. Seven parasites that emerged about the middle of September lived over 60 days and one lived 78 days. Parasites fed on sweetened water lived much longer than those that were not fed.

Length of Life Cycle

The length of the life cycle varies with the season of the year. During the early spring and late fall the life cycle averaged from 30 to 42 days, while during June, July, and most of August it averaged about 16 days, with a range of from 11 to 23 days. Between May 6 and October 21, 4346 parasites were reared and the average length of the life cycle was 18.3 days, with a range of from 11 to 42 days.

Table 2 gives the length of the life cycle based on the period between first oviposition and first emergence in the continuous life history study. Table 3 gives the average length of the life cycle for all parasites reared in each brood of the life history work.

Table 2. Showing Length of Life Cycle in Life History Study

Brood	*First Oviposition*	*First Emergence*	*Length of Life Cycle*
1	(3)		
2	May 6	May 27	22 days
3	May 28	June 11	15 days
4	June 12	June 28	16 days
5	June 29	July 15	16 days
6	July 16	July 31	15 days
7	July 31	Aug. 15	15 days
8	Aug. 15	Sept. 1	17 days
9	Sept. 1	Sept. 24	23 days

(3) The first brood of adults was present in the field prior to May 6.

Table 3. Showing the Average Length of Life Cycle of All Parasites Reared

Brood	Source	Date	No. of Parasites	Av. Length of Life Cycle	Range	
					Max.	Min.
				Days	Days	Days
2	From field collection	5-6 to 9-7	463	10.7	31	2
3	From 2nd brood	5-28 to 7-31	799	16.0	21	12
4	From 3d brood	6-11 to 8-4	932	16.0	21	12
5	From 4th brood	6-29 to 8-8	279	16.4	20	13
6	From 5th brood	7-16 to 7-31	978	15.7	23	12
7	From 6th brood	7-31 to 8-10	567	16.0	22	11
8	From 7th brood	8-15 to 8-29	266	20.0	26	16
9	From 8th brood	9-1 to 9-10	62	28.0	42	23

Period of Activity

Since the first parasitized chinch bug eggs were found on May 6 it is evident that the parasites were active before this date. The first chinch bug eggs were found on May 5.

The last emergence of parasites in the life history study in the outdoor insectary under practically natural conditions occurred October 21 and the last parasite died November 30. The period from the first parasitism in the spring to the last emergence in the fall was 168 days and to the last death 209 days.

Number of Generations

The possible number of broods was determined in an outdoor insectary by collecting parasitized chinch bug eggs as soon as they appeared in the field in the spring and rearing adult parasites. The adults were allowed to oviposit in chinch bug eggs immediately and in this way the next generation was obtained. By supplying the first adults of each generation with fresh chinch bug eggs an unbroken life history record for the entire summer was obtained. The first brood of adults was present in the field prior to May 6 as parasitized eggs were found at this date. The second brood of adults was bred from eggs on May 27, the third brood was out June 11, the fourth brood June 28, the fifth brood July 15, the sixth brood July 31, the seventh brood August 15, the eighth brood September 1, and the ninth brood September 24. The first pair of adults of the ninth generation was supplied with 17 chinch bug eggs and oviposition occurred at once. The larvæ of this brood, however, died just before pupation. The accompanying chart gives the seasonal life history and brood study at Manhattan.

Physiological Relations

Effect of Temperature.—*Eumicrosoma benefica* responds readily to temperature influences. Low temperatures of from 40° to 50° prolong the life cycle from sixteen days to forty-two or more days and prolong the length of adult life from three to ten days to as high as seventy-eight days. On July 13 several parasitized eggs were placed in an ice box where the temperature ranged between 42° F. and 55° F. One egg was removed each week and the time of emergence was prolonged just the period that the eggs remained in cold storage. The parasite that was in cold storage seven days emerged seven days later than the check, and the parasite that was in twenty-nine days emerged twenty-nine days later than normal.

On August 8 eighty-four parasites were fed on sweetened water and placed in an ice box where the temperature ranged between 40° F. and

55° F. The average length of life of these parasites was nineteen days, with extremes of eleven and twenty-seven days. Seventy-eight parasites in the check lived an average of 3.5 days, with extremes of two and five days.

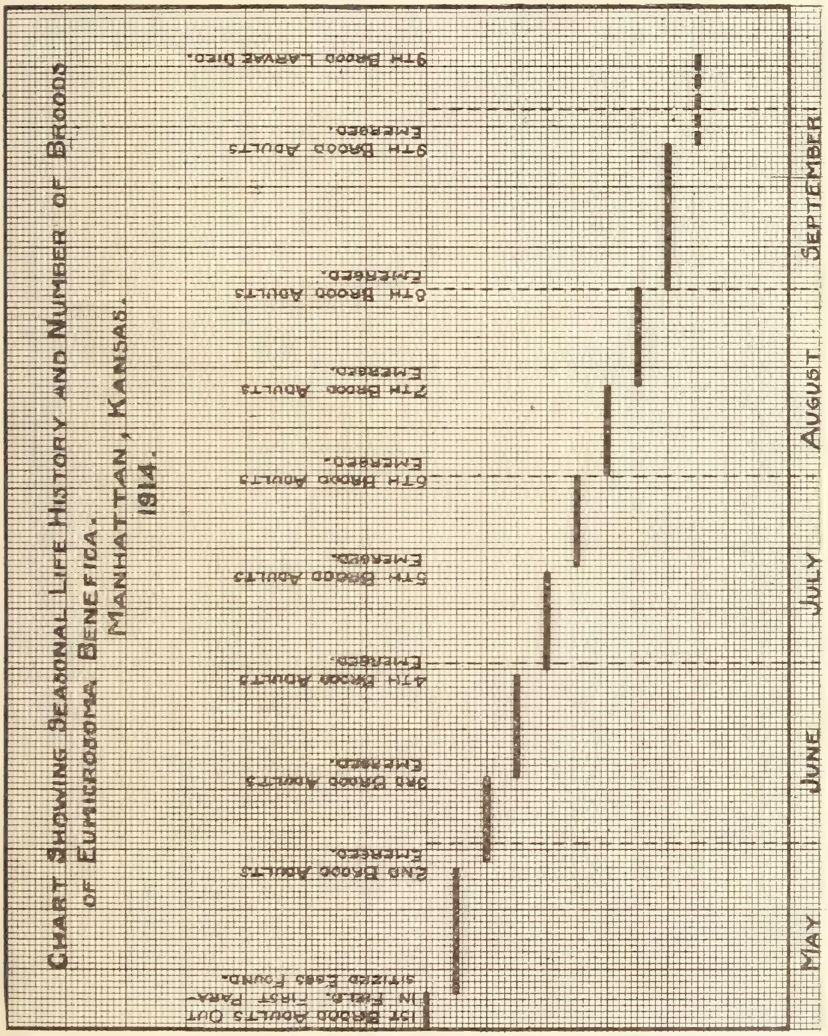

Fig. 13—Life History Chart.

Temperatures above 100° F. for three or four hours were fatal to the adult parasites when they were confined in small vials, and temperatures above 110° were fatal to the immature stages under the same conditions.

Effect of Food.—During the summer the parasites were fed on numerous substances, such as sweetened water, plain water, dew on corn plants, sap from corn stalks and gummy secretions from sunflowers. In all cases the parasites fed readily, but, with the exception of sweetened water, the effect of feeding was not appreciable in the length of life or in oviposition. Sweetened water prolonged life from a few days to several weeks and the parasites showed a greater activity in oviposition.

Table 4 gives the effect on the length of life of the adults at different seasons of the year when fed sweetened and plain water, and when not fed.

Table 4. Showing Effect of Food on Length of Life

Date	Sweetened Water		Plain Water		No Food	
	No. Parasites	Length of Life	No. Parasites	Length of Life	No. Parasites	Length of Life
		Days		Days		Days
June	17	16.5			6	4.0
7-16 to 8-1	120	7.0	3	3.6	86	3.3
8-7 to 8-17	127	10.3	48	3.0	138	3.9
9-4 to 9-17	96	9.6	35	9.2	71	9.5
9-24 to 10-17	14	26.2	9	18.0	33	15.5

Effect of Light and Contact.—The adult parasites show negative phototropism. In the vials they always crawled in between the cotton and the glass on the underside where it was darkest. If a paper label were placed in the vial the parasites would get on the under surface. When placed in a dark box which had a glass tube inserted for emergence to light the parasites seldom appeared in the tube.

The adults also show a positive thigmotropism and whenever possible they endeavored to crawl in between two closely fitting objects. In the vials they were found wedged in between the vial and the cotton plug and in the field they were often found between the leaf sheath and stalk of plants or in small cracks in the ground.

The two reactions are necessary in the life economy of the insect in its search for chinch bug eggs.

A Member: I would like to ask as to whether this parasite has transferred its habitat to the chinch bug or whether it has been present all the time in small numbers?

Mr. J. W. McColloch: Indications are that it has been present for some time. The percentage of parasitism the first year we found

the parasite was about the same in all parts of Kansas under various atmospheric and soil conditions. About 16 per cent of the eggs collected in the field were parasitized. This year 14 per cent of the eggs collected in the field outside of Manhattan were parasitized.

President H. T. Fernald: The next paper on the program will be read by Mr. W. R. McConnell.

A UNIQUE TYPE OF INSECT INJURY

By W. R. McConnell, *Bureau of Entomology.*

Introduction

The bean-leaf beetle, *Cerotoma trifurcata* Forst., is well-known in the south as an enemy of beans and cowpeas. It is known chiefly from the damage done by the adults to the foliage of these hosts, where its injury may consist merely of eating rounded holes in the leaves or may extend to the total destruction, particularly of young plants.

The first record of a food plant was made in 1877 by Professor E. A. Popenoe[1] who found the beetles damaging the leaves of garden beans in Kansas. In 1887, Professor F. M. Webster[2] recorded the total destruction of garden beans in Louisiana and Indiana. He also found cowpeas seriously damaged in Louisiana and predicted that "To the cowpea this may prove a formidable enemy, especially in the south." Popenoe later published a more complete account[3] and Dr. Chittenden[4,5] has published several important papers on this insect, giving notes upon several additional food plants, upon its life history, and recording injurious outbreaks as far north as New Jersey. A few other writers, particularly H. E. Weed,[6] have added important facts regarding this insect.

The larvæ have been described a number of times as feeding on the roots, channeling furrows in the bark of the subterranean portion of the stem, and even as burrowing up through the stem. While all these forms of injury may take place, it is evident that they are not sufficient to account for all the phenomena of the distribution and extent of damage in bean and pea fields.

In the fall of 1912, Mr. T. H. Parks, formerly of the Bureau of Entomology, and the writer, while working in the lower Mississippi Valley, discovered that the nodules on the roots of cowpeas had been damaged by larvæ resembling those of *Diabrotica.* Adults of the bean-leaf beetle were feeding upon the foliage and we suspected that the larvæ might belong to this species. The unique character of this injury led us to believe that a careful study of these larvæ in relation

to cowpeas should be made, and it was agreed that Mr. Parks should concentrate his attention upon this problem. He soon proved the identity of the larvæ and did the major portion of the work until his resignation in the following spring, when the writer took it up. The full possibilities of the damage began to be realized during the following summer when the larvæ were found to be the most destructive on the poor soils where soil enrichment through the growth of cowpeas was of the greatest consequence, and when soy beans were found to be seriously damaged in the same way. The present preliminary paper includes none of the results of the past season during which active work had been turned over to other hands, but the results obtained up to that time are deemed important enough for publication now.

Distribution

The bean-leaf beetle is found over the eastern portion of the country from New York to Minnesota and southward to Kansas and the Gulf of Mexico. It occurs in most destructive numbers in the south, especially in the Gulf Coast States.

Food-Plants

It feeds on a rather long list of plants, all of which are legumes. Recorded host plants include bush and pole beans, cowpeas, bush clover (*Lespedeza* spp.), hog peanuts (*Falcata comosa* L.), and tick trefoil or beggar weed (*Meibomia* spp.), including the cultivated beggar weed. Parks found adults on the leaves of English horse-beans (*Faba* sp.) at Biloxi, Mississippi, and pupæ near characteristically injured nodules of soy beans. The writer has found soy beans seriously damaged in Louisiana and has reared larvæ from this host. He has also found the larvæ damaging nodules on some recently introduced forage plants, such as the moth bean, Kulthi bean, and *Phaseolus* sp. In the delta region of Mississippi *Meibomia canescens* seems to be a native food plant and its nodules are damaged in the typical way. Garden peas and velvet beans seem to be exempt.

Life-History

The notes on life-history apply to the latitude of central Mississippi, most of this work being done at Greenwood. Here there are at least three generations extending over the season, and the length of different stages varies at different times of the year. The adults hibernate under rubbish, in and near cowpea fields and gardens, and in clumps of rank grass. In the delta region clumps of *Andropogon virginicus* are favorite hibernating places, these dense clumps frequently growing

on a slight elevation and permitting the beetles to pass the winter above the general level of standing water in many places.

The beetles emerge from hibernation early in the spring. At Greenwood, Mississippi, this occurs about the first of April. On the Gulf Coast this occurs considerably earlier, and in the extreme southern part of this country they may not hibernate at all. On emergence they begin to feed chiefly upon garden beans and also what native food plants they can find. After feeding for a week or more, oviposition begins.

The eggs are placed in the ground within a few inches of the base of the plants and at varying depths. In loose soil they may be found within one-quarter of an inch of the surface, but the beetles frequently place them on the under side of clods of earth, in crevices, and between the base of the plant and the earth. They may in this way be placed a couple of inches below the general surface. Occasionally they are placed on the surface in damp shaded situations. Eggs have been found in clusters of from 1 to 49, the average size of a cluster being about 12. The eggs are of a deep yellow to orange color, elliptical, reticulate, and about .70 mm. long by .35 mm. in diameter. A single female has laid as many as 795 eggs, but the average is probably considerably less than this. Oviposition continues over a period of several weeks to a month. The eggs hatch in about 18 days in the spring, while in summer this period may be shortened to a week.

The larvæ at hatching are about 1.5 mm. long and when full-grown reach a length of 8–10 mm. At first they are of a creamy to a pale orange color, and the egg shells also retain the orange color after hatching. The larvæ later become pure white. The head, cervical shield, and anal shield are always black.

They feed upon the roots, root hairs, and root nodules. They can complete their growth on either roots or nodules, or both, but seem to prefer the latter when they are available. They cut off roots and devour a portion of a cut end and may gnaw some of the bark from a larger root. When attacking nodules they cut a round hole into the nodule and usually devour the entire contents, leaving only the outer shell. They usually crawl out through the entrance hole but may cut their way on through. Several small larvæ may attack a single nodule, making a number of entrance holes. One nodule has been found to contain as many as 8 young larvæ. The larvæ usually travel along the course of roots in search of fresh nodules, but may go short distances through the soil. They have been found to injure nodules as deep as 8 inches and over a foot in a horizontal direction from the base of the plant.

The larvæ pupate in a nearly upright position in small earthen cells

near the base of the plants or their horizontal roots and in depths varying from one-quarter of an inch to three inches. The depth of the pupal cells seems to be determined largely by the amount of moisture in the soil. During dry hot weather they pupate deeper than during wet weather.

The period of larval growth varies from about three weeks in mid-summer to six weeks or more in the fall. The pupal period extends over about four days in mid-summer and may be extended over two months in the fall. Pupæ have been found in the ground as late as the first week in January and these must have remained there in this stage since the first of November.

The first generation of adults appears about the middle of June. By this time practically all of the over-wintered beetles are dead. Oviposition for this brood extends practically into July and by this time the adults of the second generation begin to appear. A third brood begins to appear during the last of August and adults continue to emerge until stopped by cold weather in the fall, usually about the first of November. There is considerable overlapping of broods during the latter part of the season and there is probably a partial fourth brood.

Natural Enemies

Climatic conditions seem to be the principal natural check upon the multiplication of this insect. A rainy winter with occasional cold snaps undoubtedly results in a high mortality. In an experiment, under what seemed to be excellent conditions for hibernation, only 11 per cent of the beetles survived the winter. The character of the growing season also influences the rate of multiplication. A few beetles are killed by a fungus, probably *Sporotrichum*, and eggs in cages frequently become covered with a greenish mould and fail to hatch. A small reddish mite was found clinging to a recently hatched larva in a cage. Mr. G. G. Ainslie has noted that small mites apparently injured the eggs. Ants have been observed carrying off larvæ after they had been dug up. A Spring-tail, as yet undetermined, seems to kill pupæ when the ground becomes cold in the fall. The only internal parasite thus far reared is the Tachinid, *Celatoria diabroticæ*, which kills a small percentage of the beetles.

Damage

The amount of damage caused by the larvæ of the bean-leaf beetle is difficult to estimate. When the larvæ appear while the plants are young and before the nodules have developed, the roots suffer seriously. When the nodules have begun to develop the larvæ then attack them. Nodules appear first on the tap root and these are frequently all

destroyed before they are half grown. Later, nodules develop on lateral roots and nearly all of these may be found and destroyed when quite small. One larva is capable of destroying a considerable number of nodules. When the attack is delayed until the nodules have reached their full size, the destruction may be as complete but the damage is probably not as great. In any case a serious outbreak of the beetle means that the nodules have little opportunity for performing their function of collecting atmospheric nitrogen. This means that the plant will not be able through the nodules to store up nitrogen later to enrich the soil. While it is true that cowpeas will make a good growth in rich bottom soil irrespective of damage to the nodules, it is in the poorer hill soils that the loss of the nodules causes a marked decrease in the size of the plants, and it is in these soils deficient in nitrogen that the nitrogen-fixing ability of the nodules is most valuable.

A correct determination of the loss in this manner from the attacks of the larvæ involves a knowledge of the nodule-forming bacteria themselves and a chemical analysis of the plants. Consequently, coöperative experiments with the Bureau of Plant Industry have been arranged, and these are still in progress. For the present, an idea of the possibilities may be gained from what is known of the value of legumes in soil renovation. Mr. Lewis T. Leonard, of the Bureau of Plant Industry, who is in charge of the coöperative work on this insect, has kindly supplied a statement, as follows: "Professor Bottomley of England has estimated from German and United States reports that on an average the legume nodule adds 166 pounds of nitrogen per acre to the soil (166 pounds of nitrogen is equivalent to about 1,844 pounds of sodium nitrate)." He also has computed from reports in his office "that in the case of the cowpea the average value of the nodules to the plant is 140 per cent of the crop without the nodules, that is, by inoculation the crop is more than doubled." The importance of the loss of the nodules on a poor soil will readily be seen.

To this damage must also be added that caused by the larvæ to the roots. In addition it must be borne in mind that the adults are capable of destroying a stand of young cowpeas. Ordinarily, after cowpeas have made a good growth, the damage by the adults is not serious.

Suggestions for Control

The possibilities for the successful control of this insect on a crop of cowpeas are limited mainly to preventive measures. Since, as Weed first pointed out,[6] the first generation is in the main produced upon garden beans, it would appear that a campaign of thorough spraying with arsenicals against the adults as soon as they appear

upon beans would reduce their numbers considerably. Black-eyed peas, which are commonly grown in gardens in the south, should also be included, and wild host plants should be destroyed.

The date of planting a crop of cowpeas is also an important consideration. It has become a well established custom not to plant cowpeas until June. This custom has come about apparently from the ravages caused by this beetle on an early crop. It is important to dodge the first generation of beetles in order to allow the plants to make a good growth before the second generation appears and to allow the poisoning of the adults on beans to take place. This can probably be done in the latitude under consideration if peas are not sown earlier than the latter part of May.

There seemed to be a possibility of finding a resistant variety of cowpeas, and accordingly experiments were started to determine this point, the Bureau of Plant Industry furnishing the seed. This phase of the work is still being carried on, but it may be said that no variety is entirely immune. The Iron cowpea is damaged much less, both by larvæ and adults, than any variety so far experimented with. In view of the fact that it is also resistant to the root-knot disease, it promises well for the purpose of soil renovation wherever it is adapted to soil and climate.

References

[1] Popenoe, E. A. Transactions Kansas Academy of Science, 1877, p. 35.

[2] Webster, F. M. Report, Commissioner of Agriculture, 1887, p. 152.

[3] Popenoe, E. A. Second Report Experiment Station of Kansas, 1899, pp. 210–12.

[4] Chittenden, F. H. Proceedings Entomological Society of Washington, Vol. II, 1892, pp. 263–4.

[5] Chittenden, F. H. Division of Entomology, Bull. 9, n. s., 1897, pp. 64–71.

[6] Weed, H. E. *Insect Life*, Vol. V, 1893, pp. 110–111.

Mr. F. M. Webster: I only wish to point out the far-reaching results of these investigations. Following the idea put forward by Dr. Forbes last night, I think this furnishes an excellent illustration. We began twenty-eight years ago with the investigation of a beetle whose injuries were supposed to be restricted to the foliage of leguminous plants. Now we find ourselves at a point where we have to go to the ecologist, and the soil expert, as we find that the larvæ of this beetle in destroying these nitrogenous nodules, largely takes away the fertilizing value of these plants, especially if growing on the higher lands where there is the greatest need of additional fertility. And it takes us into a matter which the agronomist has overlooked.

Mr. McConnell has shown the actual financial value of these nodules to the farmer as compared with the cost of sodium nitrates.

President H. T. Fernald: In the case of the papers remaining on the program, the authors are either absent or wish the papers presented by title.

At the close of this session, the regular business was transacted and the meeting adjourned at 11.30 a. m.

A New Pest, The Chrysanthemum Midge (*Rhopalomyia hypogaea* H. Lw.)

Specimens of badly infested chrysanthemum plants were received under date of March 27, 1915, from Prof. R. H. Pettit of the Michigan Agricultural College, accompanied by the statement that the above named insect, determined by the writer, was causing serious injury in the houses of a commercial chrysanthemum grower. Certain varieties, particularly mistletoe, appear to be very susceptible to injury. The plant submitted for examination had the stem from a point at about the surface of the ground to the region of the leaves, a distance of 1.5 cm., enlarged to practically twice the normal diameter, the swelling being composed of nearly approximate oval cells, each of these having a length of about 2 mm. Similar masses of infested tissue occurred in and near the midribs of the developing leaves and arrested the growth of the foliage, producing a close, ill-shaped head and the probable ruin of the plant for commercial purposes. A study of the midges and the deformities they produce convince us that this is an European species recorded from central and southern Europe as infesting *Chrysanthemum leucanthemum*, *C. corymbosum*, *C. atratum* and *C. japonicum*, and producing galls on the stalks, leaves, buds and presumably also on subterranean root stalks. The individual galls frequently form sub-conical projections from the swollen surface of the plant tissues.

This insect, like allied greenhouse species, probably breeds continuously when conditions are favorable, the initial attack being usually confined to buds (including the subterranean ones on root stalks) or tissues just unfolding from the buds. The midges transform in the gall and it is probable that hibernation or æstivation occurs either in the adult or possibly as larvæ in slowly developing, subterranean buds. The probabilities favor this insect being a serious local pest, since it has presumably become established in this country without its full complement of parasites. It is certainly desirable to ascertain the present distribution of the chrysanthemum midge in America, and growers of this popular flower would do well to adopt every reasonable precaution to keep their stock free from this insect. Badly infested plants should be burnt, and it is possible that, by cutting off and destroying infested portions of others, it may be practical to exterminate the insect in localities where it has become established without resort to more drastic measures. Fumigation with hydrocyanic acid gas, while deadly to the midges on the wing, would have little or no effect on the larvæ and could not be expected to accomplish more than prevent the insect from becoming excessively abundant.

E. P. Felt.

Proceedings of the Thirteenth Annual Meeting of the American Association of Official Horticultural Inspectors

(Papers continued)

IMPORTANT INSECT PESTS COLLECTED ON IMPORTED NURSERY STOCK IN 1914

By E. R. Sasscer

During the past year the Federal Horticultural Board has been issuing, from time to time, in the form of news letters, lists of insects and diseases intercepted on imported nursery stock by inspectors throughout the states. In preparing these lists an attempt has been made to present them in such a simplified manner as to be intelligible to the isolated inspector as well as to entomologists and pathologists. These news letters are not published, and the object of this contribution is to put on record the finding of certain injurious insects, some of which have not been listed in previous reports.

Fifty-one nests of the brown-tail moth (*Euproctis chrysorrhœa* Linn.) have been collected on French nursery stock, and three egg masses of the gipsy moth (*Porthetria dispar* Linn.) on cedar and camellia from Japan, and a single egg mass on azalea from Belgium. Larvæ of the pink boll worm (*Gelechia gossypiella* Saunders) were found in three shipments of Egyptian cotton, one of which exhibited a 20 per cent infestation and was to be forwarded to Arizona. This cotton pest is briefly described by Mr. W. D. Hunter in an unnumbered circular of the Bureau of Entomology, and, from all indications, would be a serious menace to the cotton industry if established in the southern states.

A single living adult of the olive fruit fly (*Dacus oleæ* Rossi) was discovered in a small package of olive seed from Cape Town, South Africa, after having been en route for 28 days. According to Silvestri, it requires from 47 to 49 days in Italy for the pupa to transform to the adult, and it is possible, therefore, for this pest to enter the United States through eastern ports of entry and still have ample time to reach the olive-growing sections of California prior to the emergence of the adult. In addition to the olive fruit fly, a dead specimen of what appeared to be *Dacus semispharens* (Becker) was found in the same small package.

Avocado seed from Guatemala were infested with the larvæ of an undescribed curculio (*Conotrachelus* sp.). The number of larvæ per seed varied from one to five, and the injury occasioned is not unlike

that of the avocado weevil (*Heilipus lauri* Boh.). These seed were also infested with the broad-nosed grain weevil (*Carpophilus latinasus* Say).

A single specimen of the banana root borer (*Sphenophorus sordidus* Germ.) was found in a banana plant held in quarantine from Brazil. When received the plant was apparently healthy, but, after remaining in quarantine for several months, it commenced to die down, and, on close examination, the roots were found to be riddled by the larva mentioned. According to Jepson[1] this insect is a serious pest to banana plantations in the Fiji Islands, and no variety seems immune from its attacks.

Egg masses of the European tussock or vapourer moth (*Notolophus antiqua* Linn.) have been frequently taken on various kinds of stock from Denmark, Holland, France, and Belgium. According to English writers, this insect is somewhat partial to civilized life, and frequents trees in densely populated cities, gardens, and parks. At times it is responsible for considerable damage to roses and to fruit and forest trees.

Cocoons of the Oriental Moth (*Cnidocampa flavescens* Walk.) were found on Japanese stock. This insect has an extensive distribution in the Orient, and has previously been introduced into this country. A full account of this pest is given by Dr. H. T. Fernald in Bulletin No. 114, Hatch Experiment Station of the Massachusetts Agricultural College (1907).

The citrus leaf miner (*Phyllocnistis citrella* Stainton) has been detected on Citrus and Atalantia from the Philippine Islands. According to Mr. R. S. Woglum[2] this leaf miner is a serious pest in India, and is especially injurious to citrus nursery stock.

Puparia of the papaya fruit fly (*Toxotrypana curvicauda* Gerst.) were received in a package containing an unknown vine from Mexico. This material was retained, and subsequently adults were reared. An account of this fruit fly was recently given by Messrs. Knab and Yothers.[3]

Coccids have been reported frequently, some of the more important of which are the following:

Aspidiotus destructor (Sign.) on *Mangifera verticillata, M. indica* var. *carabao, Eugenia* sp. from the Philippine Islands, and cocoanut from American Samoa.

Chionaspis wistariæ (Cooley) on Wistaria from Japan.

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[1] "Report on Economic Entomology," Department of Agriculture, Fiji, Council Paper No. 25, p. 48, 1911.

[2] Bull. No. 120, Bureau of Entomology, U. S. Department of Agriculture, p. 49 (1913).

[3] Journal of Agricultural Research, II, 6, p. 447 (1914).

Epidiaspis pyricola (Del Guer.) on pear seedlings from France.

Morganella maskelli (Ckll.) on Citrus from Java and Brazil.

Targionia biformis (Ckll.) on orchids from Venezuela and Colombia.

Odonaspis secreta (Ckll.) on bamboo from Japan.

Odonaspis sp. on grass from Brazil.

Parlatoria sp. on Mango and Citrus from Brazil.

Pseudaonidia articulatus (Morg.) on Limoncillo from Ecuador, and on Cinnamon from Colombia.

Pseudaonidia duplex (Ckll.) on Camellia, Persimmon, and tea trees from Japan.

Pseudaonidia pœoniæ (Ckll.) on Azalea, Camellia, Pear, Gardenia, *Olea fragrans*, and Andromedas from Japan.

Pseudaonidia trilobitiformis (Green) on *Jaboticaba murta* from Brazil and Citrus from Japan.

Pseudococcus ryani (Coq.) on *Sciadopitys verticillata* from Japan.

Pseudococcus calceolariæ (Mask.) on sugar cane from Brazil and flax from New Zealand.

The following list indicates by countries the number of species of insects collected on imported stock and reported to the Federal Horticultural Board by various State and Federal inspectors:

Algeria, 3.
Argentine, 2.
Australia, 7.
Belgian Congo, 1.
Belgium, 53.
Bermuda, 3.
Bolivia, 1.
Brazil, 50.
Canada, 2.
Canal Zone, 3.
Cape Colony, 2.
Ceylon, 1.
China, 13.
Colombia, 37.
Costa Rica, 7.
Cuba, 2.
Denmark, 2.
Ecuador, 4.
Egypt, 6.
England, 22.
Formosa, 2.
France, 35.
Germany, 5.
Guatemala, 13.
British Guiana, 1.
Hawaii, 1.
Holland, 58.
India, 10.
Ireland, 1.
Italy, 2.
Japan, 67.
Java, 9.
Kamerun, 3.
Korea, 1.
Mexico, 9.
New Zealand, 14.
Nigeria, 11.
Palestine, 1.
Paraguay, 1.
Peru, 1.
Philippine Islands, 24.
Reunion, 1.
Samoa, 7.
Siam, 3.
Sudan (Africa), 1.
Trinidad, 4.
Transvaal (So. Africa), 3.
Turkey, 1.
Venezuela, 3.

THE PREVENTION OF RABBIT INJURY TO YOUNG APPLE TREES

By E. N. Cory, *College Park, Md.*

(*Abstract*)

Economic entomologists are frequently asked to lend their services in preventing or controlling animal pests, that do not belong to the insect world. Such a request was made of the Department of Entomology in Maryland in December, 1913, the animal pests in question being cotton-tail rabbits (*Lepus sylvaticus*). They were reported as having badly cut the trunks of young apple trees planted on the

mountain sides. Some of the blocks of one- and two-year trees had suffered injury to the extent of 95 per cent of the entire stock. In other places the rabbits had not begun to work.

Electric welded wire screen of one-fourth inch mesh, $18'' \times 10''$, had been used in many of the orchards with success at a cost of one-half cent per tree, where the wire was bought by the carload, plus labor cost. Various washes of fish oil soap, blood, glue, hair, lime, and other ingredients had been used with little or no success. White lead and raw linseed oil in the proportion of $\frac{3}{4}$ part lead to $\frac{1}{2}$ part oil had been used on a large number of trees. This cost approximately three-fourth cent per tree, labor being one-fifth cent per tree. The rabbits gnawed through this covering in most instances.

The writer visited the place and demonstrated the preparation of concentrated lime sulphur and the method of thickening the material for brushing on the trees. Some commercial lime sulphur was used. About 600,000 one- and two-year apple trees were treated.

The lime sulphur was diluted at the rate of 1 to 9 and approximately 30 pounds of stone lime used to each 50 gallons of the diluted wash to thicken it. Five gallons of lime sulphur was placed in a barrel and stone lime gradually added and slaked in it. This tended to combine any free sulphur that remained. Water was gradually added, as needed to prevent burning and at the conclusion of the slaking to make up the wash to 50 gallons, thus giving a thickened wash of lime sulphur at a dilution of 1 to 9. Other lots were made up by first slaking the lime in large quantities, and adding the milk of lime to the diluted lime sulphur.

This material was applied by gangs of men, each of whom was supplied with a gallon bucket and a three-inch varnish brush. Each man was able to cover about 700 trees per day at a cost of one-fifth cent per tree for labor and slightly over one-sixth cent per tree for material.

The material proved very successful and the most economical wash that can be used on a large orchard.

THE ESSENTIALS OF INSECT CONTROL

By Thomas J. Headlee, Ph.D., *State Entomologist of New Jersey*

Introduction

It is purposed to treat this subject briefly from the standpoint of the insect control official. It is understood that all consideration of experimental studies so necessary to carrying on the control official's work will be disregarded and attention centered on the routine work of preventing insect pests in other states and in foreign lands from be-

coming established within the control official's territory, and of preventing insects already established within his territory from assuming the character of serious pests.

Preventing Injurious Insects and Diseases from Becoming Established

Control officials are in substantial agreement that for preventing undesirable insects from becoming established it is necessary to close the channels through which they naturally enter. Differences of opinion and practice obtain relative to the methods of closing these channels. Some officials require merely that all nursery stock shall come in under a regular certificate of inspection, totally ignoring the fact that the certificate may mean much or little. Others require the certificate and attempt also to determine to some extent the character of the person or firm shipping goods into the protected territory. Others require the certificate, inspect a certain percentage of the stock and do or do not examine the standing of the shipper. Still others examine all stock shipped in.

Examination of the various insect control laws shows conclusively that the practice of depending on the certificate is considered unsafe by many of the control officials. Indeed, the various discussions of the nursery certificate, which consume a part of the time of this association practically every year, serve to show that dependence upon the certificate as a means of preventing injurious insects and diseases from entering the control official's territory is dangerous. Many attempts have been made to better the certificate by making it state more specifically what it means.

Doubt exists in the mind of the writer whether the attempt to make the certificate more specific is really worth while in view of the fact that such action is almost certain to increase the length of that already in use or multiply the kinds used. Certificates are already as long as will readily go on a shipping tag of convenient size, and any increase in length is for that reason undesirable. The multiplication in type means confusion to the agents of the common carrier and, to some extent, both to consignor and consignee. A certificate properly dated and signed is a certificate to the common carrier's agent and, speaking generally, to the consignee. Further addition to the burdens of the carrier's agents is likely to bring about disregard for the control official's requirements. Furthermore, the consignee takes the certificate to mean that the stock is not only free from the specified San José scale and black-rot canker but from all seriously injurious insects and plant diseases. The control official cannot escape responsibility for the other parasites a given shipment may have by specifying the

troubles it may be free from. The certificate means to the consignee a clean bill of health, and the moral responsibility of the control official is not effectually minimized by specifying the particular pests from which the stock is free.

That it is desirable for the control official to know just what the certificate means should be granted without argument; but may this not be obtained without either lengthening the present certificate or multiplying the type? At each of the last three meetings of this association, it has been suggested in a more or less official way that information relative to the species of insects which are held by him to be seriously injurious should be collected from every control official, and that this information should be printed and distributed among the control officials of the United States. It is the writer's remembrance that a committee was appointed to confer with the Federal Horticultural Board relative to the matter and to induce the board to prepare such a publication. It seems sufficient to say that, regardless of the action taken, no such publication has ever been distributed.

The attempt to bring about the more complete closing of the channels through which pests penetrate the protected territory, by investigating the responsibility of the consignor in addition to requiring the regular certificate is full of difficulties and would seem to offer little protection. Its influence is almost entirely moral and, if unaccompanied by examination of a part, at least, of the incoming stock, can be expected to affect only the weak and the strictly honest. As the members of this association are perfectly aware, there is a common distinction between personal and business honesty. In using the term "strictly honest" the writer refers to the business conducted from the standpoint of personal honesty. In so far as this investigation of the consignor results in keeping close track of the incoming shipments the results are bound to be good.

The attempt to prevent the introduction of undesirable insects, by requiring the consignor to furnish prompt information of each shipment in addition to covering each by a regular certificate accompanied by inspection of a considerable percentage of the stock received, is the best method thus far developed when the funds have been limited. By such an arrangement the consignor knows that any one of his shipments may be examined and that should any be found infested he will be subjected to the closest possible scrutiny and the purchase of his stock, perhaps, advised against. He is thereby almost if not quite as effectually deterred from knowingly shipping infested stock as he would be by universal inspection. The attempt to keep track of incoming stock by requiring the common carrier to notify the control official is an unsatisfactory method from the standpoint of practical

inspection, because it usually does not give the inspector proper basis for judging the importance of the shipment.

The attempt to prevent the importation of seriously injurious insects by examining all incoming stock is theoretically the best method possible. By it the chance of an injurious species obtaining foothold would seem to be reduced to its lowest terms. As a matter of fact, it is a question in the writer's mind whether the difficulty in choosing and managing the large group of inspectors necessary does not counterbalance the advantage gained by complete inspection: whether therefore the partial inspection carried out by a small number of capable men, who, because of their small number can be more carefully chosen and better paid, does not afford as great a degree of protection as that given by the complete inspection.

The work of preventing insect pests of foreign countries from entering protected territory has only been recently undertaken. The discovery of brown-tail moth nests on pear stock from France apparently first roused the control officials of this country to the necessity of examining foreign stock. The fear of the introduction of the brown-tail and gipsy moths in this manner was so great and the volume of foreign stock likely to bring these pests so small that a large proportion of the shipments was examined. The creation of the Federal Horticultural Board, which followed the realization of this danger, brought into existence a much-needed agency for the control of the interstate and foreign shipments. This body has served the cause of insect control well by closing the mails to unexamined plants, by so organizing the importations that practically all shipments are examined, and by quarantining areas of infestation from which exceedingly dangerous insects are likely to come.

It is well to observe, however, in spite of all of these agencies for preventing insect spread that little by little many injurious species are widening their distribution, and that, as the writer stated in a former paper[1] it is probably only a matter of time until their range throughout the world will include all regions where food conditions are favorable and climate bearable. The delay in their distribution which it seems practicable to effect through control measures seems likely to prove sufficient for their new environment to become adapted to them, and for the natural enemies, which attack them in their old homes, to become distributed in their new ones, thereby reducing them to the position of the pests native to the country into which they have migrated before they have had a chance to do great damage.

In New Jersey the control officials do not desire a change in the wording of the nursery certificate or to have the consignor commit himself

[1] Journal of Economic Entomology, Vol. VI, pp. 130–133.

by any personal promise. They want a knowledge of what the certificates of the various control officials mean, to have information of what is being consigned to persons or firms doing business in the state, and to examine a considerable percentage of the total amount coming in. Of course, it is their desire to examine all stock coming in under a certificate with the meaning of which they are not familiar, all entering under a permit not backed by adequate inspection, and all which comes from regions infested with exceptionally injurious forms.

Preventing Outbreaks of Already Established Insects

Basing his opinion upon the insect and plant disease control laws now in force in the different states and upon his experience in enforcing laws of this sort in two different states, it seems to the writer that the work of preventing the establishment of seriously injurious insects is far more effectively done than is the work of controlling the outbreaks of already well-established species. Year out and year in the standard pests of the country gather headway in some parts of their range and do large damage. Sometimes the coming outbreak is foreseen and adequate preparations made to meet it, but rarely is this so. There are certain great difficulties in the way of handling this problem in an efficient manner. The first of these is the securing of adequate information as to the abundance of the obscure stages in different parts of the area. The second is found in interpreting such data as may be collected. The third is the placing of this information before the public in such a fashion that the persons who should have it, will get it and act upon it.

The problem of determining the abundance of the pest can be solved only by extensive and continuous scrutiny—that type of scrutiny which will keep the control official informed the year round as to just what each stage of each pest is doing and how much above the normal the existing density of the infestation is. A few control officials practice this regular and satisfactory method of obtaining information to some extent, but the number doing it is small and those that do make use of it rarely attempt to cover the whole field.

The problem of interpreting the data thus gathered is difficult, partly because the data of the findings and the results during the growing season of previous years are not only meagre but not organized in such a fashion as to render them available and partly because the effect of natural enemy and of weather conditions is too poorly understood. We need the accumulation of experience along these lines that comes only as the result of well-directed effort. The control officials should begin this accumulation and the attention of experimentalists should be drawn to this field of entomological work.

The problem of laying this information before the persons concerned in a really effective fashion (that fashion which will produce effective action) is not by any means easy, but it seems to the writer less difficult than the other two. With laws sufficiently powerful and proper organization of the people who are to be protected, the adequate sort of action could be secured.

Conclusions

It is the writer's strong conviction that the most efficient protection of the control official's territory will not come through increasing the complexity of certification but rather through that coöperation of control officials which will give the information sought without increase in red tape.

It is further the writer's belief that in its last analysis, the efficient protection of the territory depends upon the more or less complete examination of stock coming into it and that a very valuable prerequisite is advance information of the source, nature, extent, destination, probable date of arrival, and consignee of each of the various shipments.

It is also the writer's conviction that the prevention of the establishment of new pests is far more effective than is the control of outbreaks of insects already established, and that the time is at hand when a more satisfactory reduction of the latter must be effected.

[*Papers read by title*]

NOTES ON THE ONION MAGGOT IN 1914

By A. I. Bourne, A.B., *Massachusetts Agricultural College*

In any treatment of the season's work against the onion maggot, reference should be made to the general climatic conditions prevailing in the spring of 1914, in so far as they had any bearing upon the experiments undertaken.

The early spring in Massachusetts and especially in the Connecticut Valley was in many respects unusual. Following a winter in which were several intervals of very severe cold, there was a long period of cold, rainy weather which continued well through April and into May. This handicapped the farmer to a considerable extent, for except in especially favorable locations, the land was in no condition to be worked until very late, and so planting was much delayed. The experimental plots could not be handled until fully three weeks later than in the previous year, and at least two weeks later than in 1912. As a result, at the time when normally the onion flies begin to make their appearance in the field to deposit their eggs on young plants, these plants were

either just breaking through the ground or were not yet in sight. The field work, therefore, was begun much later than before and ran until late in the summer.

Upon frequent examinations, it was soon observed that the infestation was very slight compared with former years. Inquiry revealed that this was noticed quite generally by onion growers in this region. Along with this fact may be noted that two other very common pests, the Colorado potato beetle and the squash bug, were also conspicuous for their relative scarcity of numbers. Whether there was any direct connection between the winter with its periods of severe cold, the late spring season and this marked scarcity of these common pests which normally occur in approximately the same relative abundance from year to year, or whether it was merely a curious coincidence, it is hard to determine.

The season's work was planned in general to follow out the lines begun the previous year, to corroborate the results of that season's work, and secure additional data as to details of manipulation of the various materials used.

Previous work had demonstrated clearly that remedies and methods usually recommended for the control of the onion fly were out of the question for use in large fields, both because of the initial cost of the substances themselves, and the great expense for labor necessary to prepare and apply them. Furthermore, most if not all of them depended for the protection they gave, upon frequent renewals, all of which made their expense mount up to a prohibitive figure. In fact, their cost would often be higher than the loss caused by maggots, if no treatment other than pulling out infested plants during weeding were given.

Therefore some method of applying treatment at the same time, or in connection with planting, seemed to offer the best chance of success. This was taken up in 1913, as reported in the April number of the Journal of Economic Entomology for 1914. The results of that season demonstrated that several of the materials used were of so little value that further work with them was impracticable. In this class were naphthalene, soluble sulphur, powdered tansy, oil of tansy, etc. Some of these were out of the question because of cost and difficulty of securing in large quantities, and some had a decidedly injurious effect upon the growth of the onion. This was true especially of naphthalene. It appeared to control the maggots but at the same time seemed to prevent germination to a large extent. Other substances did not appear to have any effect upon either the plants or the maggots, at least when used in quantities practicable from the standpoint of expense.

Germination tests carried on during the winter furnished some further light upon the relative values of the different materials.

In the field experiments, only those materials which from the previous year had appeared of value, were given a trial. The method of application followed was that of using an ordinary onion planter with the covering wheel removed. This left the seed uncovered in the rows. The different substances were then applied on top of the seed and the rows covered by hand. This manual work was necessary from the fact that it was impossible to secure a machine with the supply tank behind the seed dropper, and for several reasons the alterations could not be made in time.

It was evident that the plants in rows which had been treated were retarded to some extent in their early growth, as compared to those in untreated or check rows. This caused the plants in treated rows to appear above ground a few days later than in check rows, but as the season progressed they apparently recovered from the slight early check and in the latter part of the summer there was very little, if any, difference apparent.

As mentioned above, the naphthalene, when used alone, had a decidedly injurious effect upon the germination and caused a very irregular "stand." However, when diluted by mixing with a substance less powerful as a repelling agent, it appeared safe and warranted a continuance of its use in the experiments.

The scarcity of maggots in the experimental plots was very pronounced. There were fewer infested plants found in both plots on check and treated rows combined, than in former years had been found in the check rows of one plot alone. In fact, the total number during all the present season was less than one-half those found in 1913 in the check rows of one plot. The number of check rows was the same for both years.

This extremely light infestation at first gave rise to some doubts as to the possibility of securing anything like trustworthy data. The results that were obtained, however, from the whole season's records, bore out in general those of the previous years, although on a smaller scale, due to the meagre numbers of the maggots found.

The degree of protection given by the different treatments was approximately the same as before. This was also true in the relative abundance of maggots in check and treated rows, so that although the totals were much smaller, their relative standing agreed with those of the previous year.

It was very evident that for the successful working out of this plan of applying treatment at the time of planting, a special design of planter would be required. A machine was purchased which seemed

to fit nearest the type desired. Several necessary changes were made, however, such as placing the feed or fertilizer tank so as to allow its emptying behind the seed dropper, together with other alterations, being careful all the while to keep the whole weight so well balanced as to allow smooth running in the field and avoid clogging the seed dropper, while still allowing enough weight on the covering wheel to cause it to cover the soil over the rows and roll it down evenly. Considerable time was given to this, and the aid of a high rate mechanic employed to make the necessary changes. Circumstances prevented its completion and use during the present season, but in its employment another year it is hoped that several of the factors of variation entering into the problem may be eliminated and thus enable the securing of more reliable data as to the relative value of the different treatments, based on their effectiveness against attack.

THE APPLE FLEA-WEEVIL IN ILLINOIS

Orchestes canus

By P. A. Glenn, *Urbana, Ill.*

In June, 1901, a small black rhynchophorous beetle was discovered at several points in southern Illinois feeding upon the foliage of apple, causing in some instances considerable damage. The species was at first supposed to be *Orchestes pallicornis* Say, but was later ascertained to be *Orchestes canus* Horn. This species was described by Dr. G. H. Horn in 1873 from specimens of adults from Michigan and Colorado. So far as we have been able to learn, there is no further reference to it in entomological literature until 1901, when the first published account of its injurious habits appeared under the title "A New Apple Insect," in a paper read by Dr. S. A. Forbes before the Illinois State Horticultural Society and published in the Transactions of that society for the year 1901. A more extended illustrated article, prepared by Mr. Charles A. Hart, was published in 1911 in the Twenty-Sixth Report of the State Entomologist of Illinois. A paper entitled "The Apple Flea-weevil in Illinois," by Stephen A. Forbes, was published in 1912 in Volume 46, New Series, of the Transactions of the Illinois State Horticultural Society, and another paper entitled "The Apple Flea-weevil," prepared by the writer, was published in 1913 in Volume 47 of the Transactions of the same society.

General Description of Stages

The adult of the apple flea-weevil is about one-eighth of an inch long, rather robust, and of a uniform dull black color throughout. The eyes are large, almost meeting in front, and the beak is only slightly

curved and rather stout. The posterior legs are fitted for jumping, the hind femur being enlarged. When disturbed, the beetle either jumps or drops to the ground and feigns death.

The egg, which is deposited in the veins of the leaves, is smooth, yellowish in color, rather bluntly rounded at the ends, and slightly curved.

The larva is flat, yellow in color, and about three-sixteenths of an inch in length when full-grown. The segments of the body are distinctly marked. The body is much wider and more bluntly rounded anteriorly than posteriorly, the segments after the sixth decreasing gradually in width, the last segment being very narrow and ending in a rather acute point.

The pupa is white and resembles other rhynchophorous pupæ of nearly related genera.

History in Illinois

It was first found injurious to the apple at various points in southern Illinois in June, 1901, by Messrs. E. S. G. Titus and Charles A. Hart, who were at that time, as Dr. S. A. Forbes's assistants, making a study of apple insects in that part of the state. It was again found by Mr. Titus the following spring and by Mr. E. P. Taylor throughout the same region in 1905, and by Mr. Hart in western Illinois in 1906. The following is quoted from Mr. Hart's article in the Twenty-Sixth Report of the Illinois State Entomologist: "In Illinois we have seen it or its characteristic injuries at about thirty different towns: In Pulaski, Union, Jackson and Williamson counties in extreme southern Illinois; in the prairie fruit region of Washington, Jefferson, Marion, Clay, Wayne, Edwards and Richland counties; in Jersey, Calhoun and Pike counties in the western part of the state; and in Coles and Christian counties in south-central Illinois. It is represented in our collections by several specimens labeled 'N. Ill.,' and by one from Normal, McLean county; and it will probably be found to infest apple trees throughout the state."

During the last three years it has been more or less abundant in all the southern and western counties above recorded. In some localities the beetles were abundant enough to be of considerable economic interest and injuries have been quite serious, especially in orchards in which the foliage was scanty.

Character and Extent of Injury

The injury is caused both by the larvæ which work as miners in the leaves, and by the adults which feed upon the leaves. The injury caused by the larvæ is very much less serious than that caused by the beetles, but frequently the mines are so plentiful that nearly every

leaf on the tree contains one or more. The beetles in feeding work on the under sides of the leaves and eat out the soft tissues between the veinlets, leaving the epidermis of the upper surface of the leaf uninjured. The pits thus made by them are from one-half to one millimeter in diameter, and a number of them are usually made together, being separated only by the veinlets, which are left uninjured. Badly injured leaves present a sieve-like appearance when viewed from beneath. A single beetle confined for several days on fresh leaves made an average of nine such feeding-pits a day. Since the number of beetles on a tree frequently equals the number of leaves, it will readily be seen that they are capable of becoming a very serious pest. The injury, however, is usually not very serious, but varies greatly in different localities and in different seasons. The reduction of leaf surface caused by the beetles varies from a fraction of 1 per cent to 50 per cent or more, of the entire leaf surface. A reduction of 50, or even 25 per cent of the leaf surface in this way is a very serious injury, since it not only deprives the tree of a large per cent of its food elaborating tissues, but the removal of the epidermis of the lower surface in so many places exposes the soft tissues of the leaf to the drying effects of the atmosphere, and to the injurious action of spray mixtures, and opens the way for the entrance of the spores of injurious fungous diseases, resulting usually in the total loss of badly infested leaves.

Life-History and Habits

The insect is single-brooded. The winter is passed by the adult among leaves and grass and under clods or in cracks in the ground, under and near trees which they infest in orchards or woodlands. These hibernating adults become active in spring as soon as the frost is out of the ground, or about the last week in March in the latitude of St. Louis; and ascend to the branches, there to await the appearance of the leaves. As soon as the leaves appear they begin to feed on them, and by the middle of April or a little later, begin to deposit eggs. The eggs are deposited in the large veins of the leaves, in longitudinal cavities gnawed out from the under side by the female. Egg-laying continues for about a month, or to about the middle of May, after which time the adults soon die. The egg hatches in four or five days and the larva as it feeds constructs a mine extending toward the edge and usually towards the tip of the leaf. When the edge of the leaf is reached the mine becomes a blotch-mine. The larva matures in about three weeks and constructs within the mine a sort of cocoon, within which it pupates, and from which a few days later the adult beetle emerges. These mines when fully developed are brick red in color and are quite conspicuous. As a result of the wound made by

the female in depositing the egg, a swelling is produced in the vein at the point where the incision was made, causing the vein to angle upward slightly at this point. The new generation of adults begin to emerge about the middle of May, and continues to emerge till the second week in June, and are to be found during the latter part of May and the whole of June feeding on the foliage of apple and nearly related trees in orchards and woodlands. By the latter part of June they begin to descend to the ground and hide away among the leaves and grass, and in the soil, where they remain for the rest of the season, apparently without food, and during the following winter, to reappear in spring. By the end of the first week in July all the beetles have disappeared from the trees. These adults are quite active during the month of June, and may be seen flying from tree to tree in the orchards. For the rest of the season they remain dormant. When a leaf upon which a beetle is resting is disturbed the beetle usually falls to the ground and feigns death.

Food Plants

Larval mines have been found in the leaves of apple, crab-apple, and cratægus. The adult beetles feed upon the leaves of apple, crab-apple, cratægus, wild cherry, and choke cherry, and an occasional feeding puncture has been found on leaves of pear trees growing in apple orchards. When confined in a cage on pear leaves, they will feed freely on them but will not deposit eggs in the veins. The adults of the new spring generation evidently fly about considerably, since they are to be found throughout woodlands, near infested orchards wherever the trees above mentioned are found.

Control Measures

The serious injury caused by this insect in some localities during the spring of 1913 made it seem advisable to devise some means of controlling it, and the writer was selected for this work. Experiments began June 10, 1913. At this time the hibernating beetles had disappeared and the adults of the new generation were feeding on the foliage in large numbers. The work was continued the following spring, beginning early before the hibernating beetles had emerged from their winter quarters. The results of the experiments may be briefly summarized under the following heads: Sticky bands, arsenical sprays, and contact sprays.

Sticky Bands.—At the time when the experiments began many beetles were seen crawling up and down the trunks of the trees. A number of trees in a badly infested orchard at Newton, Ill., were banded with tanglefoot, with the expectation that many of the beetles

would be trapped in this way. Five days later an average of 423 beetles was found on these bands. Two such bands were placed on the trunks of several trees, and in three days an average of 656 beetles to the tree had been caught. The following spring 64 trees in this same orchard were banded early before the beetles had emerged from their winter quarters, in the hope that they might be caught in large numbers while ascending the trees. The first beetles to emerge in spring were rather sluggish and attempted to reach the branches of the tree by crawling up the trunk, but later when the weather became warmer, many of them flew directly from the ground to the branches, with the result that while the beetles which attempted to crawl up the trunk of the trees were prevented from doing so, and many of them were caught in the bands, others succeeded in getting past the bands by flying. Many beetles crawling up the trunks of the trees were observed to take wing and again alight on the trunk, and others flying from the ground were also observed to alight on the trunk. Some of these alighted on the bands and were unable to extricate themselves; a large proportion of the beetles which were caught in the bands were caught in this way, and for this reason the wider the bands were the greater was the number of beetles caught. It was estimated that bands from three to five inches wide placed about the trunks of trees reduced the number of larval mines in the leaves of the banded trees about 50 per cent. Wider bands would be more effective but also more expensive, and it is doubtful if it pays to go to the trouble and expense of using a protective measure whose efficiency is only 50 per cent.

Arsenical Sprays.—Since the larvæ of this species are leaf-miners, there is no way of reaching them with arsenical sprays; but the adults feed upon the tissues of the under side of the leaves and hence arsenical sprays applied so as to cover the under sides of the leaves should theoretically be effective. Sprayed orchards, however, have suffered almost as badly as unsprayed ones. This fact may possibly be explained in several ways: viz., the beetles may be less susceptible to poison sprays than other insects that are easily controlled by them; the beetles may possibly be able to discriminate between poisoned leaves and those not poisoned, and in this way avoid the poison; the spray may not have been applied so as to cover thoroughly enough the under sides of the leaves where the beetles feed; and lastly, the sprays may not have been applied at the proper time.

By inclosing beetles in a cage with poisoned leaves it was found that when they fed freely some died within a day or two while others lived for a week or more, indicating that while they are not immune from poisons, some are much less susceptible to poison than others, or else feed less freely upon poisoned tissues.

By confining beetles in a cage containing unsprayed leaves, and also leaves sprayed with various combinations such as arsenate of lead and water; arsenate of lead, water, and flour paste; arsenate of lead and soap; lime-sulphur; and Bordeaux mixture; it was found that the beetles fed much more freely on the unsprayed leaves than on those sprayed with mixtures containing either soap, lime-sulphur, or Bordeaux. Leaves sprayed with the arsenate of lead and water and with arsenate of lead, water and flour paste were eaten nearly as freely as the unsprayed leaves. It is probable, therefore, that the addition of lime-sulphur or Bordeaux mixture to an arsenical spray renders it ineffective, since they are both distasteful to the beetle and help it to avoid the poisoned leaves. Later observations tend to confirm this conclusion. This last spring the writer was in an orchard where the flea-beetles were very numerous. The owner of this orchard had sprayed several rows of trees with arsenate of lead and water, and several adjoining rows with arsenate of lead and Bordeaux. Two days later dead beetles were lying thick on the ground under the trees sprayed with the arsenate of lead and water, but hardly any could be found under the trees in the rows sprayed with arsenate of lead and Bordeaux. The spraying in this case had all been done the same day, the spray applied in the same manner in both cases, and the beetles were equally abundant in all the rows at the time the spraying was done. The difference in results must therefore have been due to the fact that Bordeaux was used in one case and not in the other.

The beetles' habit of feeding almost exclusively on the under sides of the leaves suggests the necessity of directing the spray upward, rather than downward or horizontally as is usually done, especially early in spring. In the spraying mentioned above, special care was taken to cover the lower sides of the leaves, and the large number of beetles poisoned in the one case is evidence that this method of spraying is quite effective.

In one experiment 24 trees were sprayed with arsenate of lead, 4 pounds; flour (made into a smooth paste by scalding), 8 pounds; and water, 100 gallons. The spray was directed upward so as to cover thoroughly the under sides of the leaves, no attention being paid to the upper sides, with a pressure of about 150 pounds per square inch. Two days later dead beetles were lying thick on the ground. On a canvas about 90 square feet in area, which was spread under one of these trees as soon as the spraying was completed, 720 dead beetles were found two days later. It was estimated that an average of over 3,000 beetles to the tree had been poisoned in this way, and that this number represented between 70 and 80 per cent of the beetles on the trees before spraying began. These results also indicate that the

method of applying the spray so as to cover the under sides of the leaves is at least moderately effective.

In order to determine the proper time to spray, one has only to recall the seasonal history of the species. The beetles feed upon the leaves of the trees about two weeks before egg-laying begins to any extent. Egg-laying begins shortly before the trees come into bloom, and continues for about four weeks. Spraying should therefore be begun before the trees are in bloom, in order to destroy the beetles before eggs for the new generation are deposited. If spraying with arsenicals is delayed until after the petals fall, a large proportion of the eggs will have been deposited and no amount of spraying at this time or later can prevent the development of the larvæ and the final emergence of the adults of the new generation.

The adults of the new generation are to be found on the trees throughout June, hence spraying to destroy these and so prevent them from injuring the foliage should begin about the first week in June.

Many orchard men do not use an arsenical spray before trees are in bloom and hence, for this reason alone if for no other, spraying has proven ineffective so far as the development of the new spring generation is concerned.

It appears, therefore, that the apparent ineffectiveness of arsenical sprays has been in a measure at least due to each of the four causes above mentioned, and it seems very probable that by the observance of the following suggestions satisfactory results will be secured: 1. Increase the amount of arsenate of lead to 3 pounds of the paste to 100 gallons; 2. Omit the fungicide from the arsenical spray when spraying to control the apple flea-weevil; 3. Spray with a pressure of 200 pounds or more, and direct the spray so as to cover the entire leaf surface; and 4. Begin spraying while the fruit is in the cluster-bud stage, spray again after the majority of the new generation of beetles have emerged, and, if necessary, follow this spraying with another as soon as possible.

Contact Sprays.—In the early experiments it was found that the beetles are very easily killed with kerosene emulsion and nicotine sprays, the only difficulty being in getting the spray on them in sufficient quantities. To accomplish this two large canvases were made, each 15 by 30 feet. These were spread beneath the trees while they were being sprayed. The spray was driven under a pressure of 200 pounds or more to the square inch, and directed upward so as to strike the under sides of the leaves. As soon as the spray strikes the leaves the beetles fall to the canvas, where they are killed by the kerosene. A 5 per cent emulsion is fairly effective, but a 7 per cent emulsion works much better. Black-leaf-40, at the rate of 1 pint to 100 gallons of

water, is about as effective as an emulsion containing 5 per cent kerosene. This method works well when the trees are not too large and the branches are trimmed up so that the canvases can be operated without obstruction, but in orchards in which the trees are large, and the lower limbs are so low that their tips rest on the ground, it is very difficult to spray thoroughly and to manipulate the canvases expeditiously. The canvases used were made of heavy unbleached muslin. Strips were nailed across the ends of each to facilitate the handling of them. One by taking hold of one of these strips can drag the canvas from one tree to another, and in this way two men or boys can move the canvases from one tree to another about as quickly as they can walk the distance.

This method of combating the apple flea-weevil has the advantage of giving immediate results, and of giving the orchardist the satisfaction of seeing the beetles lying dead on the canvas at his feet as soon as spraying has been completed. It has the disadvantage, however, of requiring an extra application for which the apple grower has little time to spare, and hence will probably not be employed extensively except as a last resort to reduce the number of beetles of the new generation in June when earlier treatment has failed to suppress them.

Fortunately, it is only occasionally that this insect becomes troublesome, and when it does, the apple grower will doubtless be able to control it by making such alterations in his usual program and methods of spraying with arsenicals as to adapt them to its peculiarities.

AN OUTBREAK OF THE ALFALFA LOOPER

(*Autographa gamma californica* Speyer)

By J. R. Parker, *Assistant Entomologist, Montana Experiment Station, Bozeman, Montana*

The most striking entomological feature of the season of 1914 in Montana was an outbreak of the alfalfa looper (*Autographa gamma californica* Speyer). This insect has been known to occur in Montana for a number of years, but until the present season it has never been abundant enough to be considered a pest of even the slightest importance. The sudden appearance of millions of looper larvæ in the alfalfa fields was so unexpected and unusual that farmers were thrown into a panic and requests for advice poured into the station from all sections of the state. Many alfalfa growers were especially alarmed because they believed the looper to be the dreaded alfalfa weevil.

Extent of the Outbreak

In Montana the insect attracted attention in all parts of the state but was particularly injurious in the central and south central countries. Definite records of injury were either reported or personally made in the following counties: Sheridan, Dawson, Custer, Rosebud, Big Horn, Cascade, Broadwater, Jefferson, Madison, Gallatin, Missoula, and Sanders.

The outbreak in Montana was so widespread that we were much interested to know how far it extended into other states and a letter of inquiry in regard to the occurrence of the insect in 1914, was therefore, addressed by Professor Cooley, to entomologists in all of the states west of the 96th meridian. By this means it was learned that it had been abundant enough to attract attention and do considerable injury in the following states: South Dakota, Wyoming, Colorado, Oklahoma, Utah, Nevada, California, Idaho and Oregon. Dr. C. Gordon Hewitt wrote that it was also unusually abundant in southern British Columbia and Alberta. Negative replies were received from North Dakota, Nebraska, Kansas, Texas, Arizona, New Mexico and Washington. The courtesy of the several entomologists who so promptly furnished the above data is greatly appreciated and is here acknowledged.

The remainder of this paper is based on observations made by the writer within the state of Montana, with the exception of several references to statements made by entomologists in other states.

Seasonal History

During the first week in May a day-flying Noctuid moth attracted attention in many parts of the state by its unusual abundance. In Bozeman it was particularly abundant about currant blossoms, while in the Clark's Fork Valley, thousands of the moths were attracted to the apple orchards, where they caused some apprehension among fruit-growers. Mr. T. H. Parks writes that in southern Idaho the moths were particularly attracted to cherry blossoms. As a matter of record a number of moths were collected and were determined by Mr. J. A. Hyslop of the Bureau of Entomology as *Autographa gamma californica* Speyer. Because of this insect's former record the incident was considered of but little importance and was for the moment forgotten. The writer happened to be in Billings on June 9 and there learned that some insect was doing great damage to alfalfa on the Huntley Project which is in the Yellowstone Valley about fifteen miles east of Billings. The following day was spent in visiting alfalfa fields on the Project. Everywhere sweet clover and alfalfa were heavily infested with a semi-looper which was recognized as the alfalfa looper.

At this time, June 10, the majority of the worms were in the third

and fourth instars, although some had already pupated and there were many that were still very small. The larvæ were at the height of their abundance on June 15 and continued in diminishing numbers through the first week in July. From pupæ collected in the field on June 10, moths emerged June 25, other moths reared from the first brood of worms emerged as late as July 30.

A second brood of larvæ was expected in late July or early August but so abundant were insect parasites and a bacterial disease that no more larvæ were observed at any time during the remainder of the season. Several adults were taken in the Gallatin Valley during the first week in September.

Plants Attacked and Nature of the Injury

Sweet clover (*Melilotus alba* Lam.) was the favorite in a long list of plants fed upon the larvæ. Sweet clover plants standing in the midst of alfalfa were generally stripped bare of all foliage, while surrounding alfalfa plants were only partially defoliated. Alfalfa was second only to sweet clover and because of its much greater abundance was the plant by far the most generally attacked. When gardens were invaded lettuce was most severely attacked and wild lettuce (*Lactuca pulchella* D. C.), was stripped to the stems wherever the loopers were abundant.

Larvæ were seen feeding upon the following hosts: Sweet clover, alfalfa, red clover, white clover, alsike clover, flax, sugar-beets, corn, lettuce, carrots, onions, peas, beans, cucumbers, muskmelons, watermelons, squash, currants, gooseberries, raspberries, dock (*Rumex crispus* L.), wild lettuce (*Lactuca pulchella* D. C.), lamb's-quarters (*Chenopodium album* L.) and sunflower (*Helianthus* sp.). From Idaho, Mr. Parks reports the larvæ as feeding upon apple foliage.

Grains and grasses were never attacked even where adjoining heavily infested alfalfa fields. Sometimes the larvæ would crawl to such crops for the purpose of spinning their cocoons.

The first crop of alfalfa was nearly ready for cutting when the looper larvæ began to attract attention. In most instances the injury was not noticeable from a distance, but upon close examination it could be seen that a large percentage of the leaf area had been destroyed. Where the infestation was heaviest, fields presented a whitened appearance quite similar to characteristic alfalfa weevil injury. It is hard to state the amount of the injury to alfalfa as very few farmers make a practice of weighing their hay each year. However, on the Bureau of Plant Industry farm at Huntley, where careful records of the weights of all crops are made each year, it was found that the yields from the first cutting were approximately one-half ton less per acre

than for several previous years. A heavy infestation of the alfalfa looper was the only apparent cause for this sudden falling off in weight. The yield was noticeably light wherever the infestation was at all severe. The quality of the hay obtained was also greatly lowered, for the loss in weight was borne by the leaves rather than by the less valuable stems.

Sweet clover was more severely attacked than alfalfa, but as very little is grown for hay, no estimate of the loss in tonnage could be obtained. Many patches growing wild were stripped entirely bare of foliage and in some of them the larvæ were astonishingly abundant. One patch was seen that was literally covered with loopers. On one plant forty-five worms were counted on one small branch and the remaining branches were just as heavily infested, while the ground beneath was covered with a squirming mass of larvæ.

When infested alfalfa was cut, thousands of loopers were left with but a scanty supply of fresh green food and they at once began a migration to other crops. Such a migration was seen at Huntley. An infested crop of alfalfa was cut on June 9 and on the following morning a heavy migration of worms was taking place from the cut alfalfa to an adjacent field of sugar-beets. In less than twenty-four hours from the time the alfalfa was cut, twelve rows of beets at the edge of the field had been eaten clear to the ground and others were much damaged. The owner was attempting to save his beets by spraying with Paris green, but so fast were the worms coming in that the damage was done before the poison could take effect. He was advised to turn water into an irrigating ditch that separated the two fields and by this means the migration was stopped.

Many beet fields were invaded in like manner and their scalloped and irregular margins were very noticeable as one drove along the highways. However, beets that had been defoliated soon sent out new tops and by harvest time could not be distinguished from those that had escaped attack.

Gardens and some of the field crops were attacked in proportion to their nearness to infested alfalfa and sweet clover. A half-acre garden which had been planted to squash, melons, cucumbers, beans, peas, corn, and beets was seen about ten days after it had been invaded by loopers from a neighboring alfalfa field. Not a vestige of the squash, melons, or cucumbers remained; beans and peas existed only as bare stems; corn was badly eaten and beets were sending out new tops after having been eaten to the ground.

Many patches of melons that were attacked made a new growth and set much fruit, but a set-back of several weeks in a growing season which at the best is short, was sufficient to prevent the melons from ripening before the coming of fall frosts.

In several fields observed, flax was stripped of its foliage, but new leaves were very quickly developed and the yield was not materially reduced.

Gooseberries, raspberries, and currants were attacked only where the worms were very abundant and other food was scarce.

Control

The outbreak was so sudden, unexpected and of such short duration that experimental work in control could be carried on only in a very limited manner.

Paris green at the rate of 1½ pounds in 50 gallons of water, and arsenate of lead at the rate of 4 pounds (paste) in 50 gallons of water were effective in killing loopers, but in the case of heavy migrations some method more immediately effective must be employed.

One farmer reported that a dry ditch with the soil at the sides well pulverized was an effective barrier. Another reported killing many worms in his beet field by rolling as it is practiced at thinning time to break the surface crust.

The most successful method of preventing the larvæ from invading crops other than alfalfa was to keep a stream of water flowing through the main irrigating ditches. On the Bureau of Plant Industry farm at Huntley, a count was made of the worms carried past a certain point on an irrigating ditch three feet in width. It ran close to four hundred worms per minute or 576,000 per day. Nearly all of these were drowned and those that escaped were carried into a section where there were no farms. Some of the worms sink immediately when placed in water, while others will float for some time. Once in the water, they seem unable to get out, unless they become lodged against projecting weeds, sticks, etc.

The immediate cutting of infested alfalfa, followed by discing and dragging, as is practiced in Utah for the alfalfa weevil, was recommended, but because of the presence of natural enemies no data as to the effectiveness of these measures were secured.

Natural Enemies

Birds destroyed great quantities of looper larvæ. Brewer's black bird was of great benefit in this respect and could be seen in large flocks feeding upon the caterpillars at haying time.

Insect parasites and disease were deadly in their attacks upon the hordes of worms, killing them off in such numbers that the second brood of larvæ did no damage and in fact was never seen, although a few adults were observed in September. The most effective of these natural enemies were two species of *Apanteles* and a bacterial disease.

Their presence was not noticed until after the worms had reached the height of their abundance, but during the last week in June the white cocoons of the hymenopterons and the blackened and putrid bodies of worms killed by disease were to be seen everywhere in the infested territory.

In the Bureau of Entomology bulletin 95, Part VII, the author, Mr. James A. Hyslop, makes the following statement: "The alfalfa looper has been held in check by a number of parasites and a disease . . . . The time may come, however, when these natural enemies may themselves suffer reverses and temporarily fail to hold the pest in check." Mr. Hyslop's prediction has certainly come true and the wisdom of collecting and publishing biological data concerning insects that are not of immediate economic importance is again emphasized.

THE CITRICOLA SCALE

(*Coccus citricola*, Camp.)

By H. J. Quayle, *Citrus Experiment Station, Riverside, California*

Six or seven years ago some of the horticultural officers of southern California, particularly Mr. Cundiff and Mr. Pease, horticultural commissioners of Riverside and San Bernardino Counties, had observed cases where fumigation was not effective against what was supposed to be the soft brown scale (*Coccus hesperidum*). In these cases, too, the scale was generally distributed over the old trees in the grove, while usually the soft brown scale occurs more commonly on young trees or a few twigs or branches of older trees. Some specimens of what was supposed to be this new variety of scale were at the time sent to the Bureau of Entomology as well as to the writer. The scales were identified in both cases as *C. hesperidum*. But further general observations showed that the scale in question was very sparingly attacked by parasites, and that ants were not attracted to it in large numbers, both points being the reverse of what is true for *C. hesperidum*. At about the same time this variety was discovered at Claremont, and it was identified by Mr. Essig as *Coccus longulus* and later as *C. elongatus*. When an incidental study of this scale was started by the writer in 1911, it did not appear to agree positively with any of the species that it had previously been placed under. In 1913 Mr. Roy E. Campbell was engaged as an assistant to work particularly on this scale, and as a result of these studies, it was determined as a new species and was given the name of *Coccus citricola*.[1]

This scale is now known to occur over widely separated localities in California and attacks citrus trees primarily. It has been found also

[1] A New Coccid Infesting Citrus Trees in California. By Roy E. Campbell, *Entomological News*, Vol. XXV, May, 1914.

on pomegranate, nightshade, elm, and English walnut where these occur near infested citrus. Its origin is at present unaccounted for, but further studies may place it under some foreign form already described. The fact that it is a pest at present of citrus entirely and has not been taken on any native plant seems to indicate that it has been introduced.

The citricola scale has spread very rapidly in some sections. While it was practically unknown in Tulare County two years ago, it now occurs in most of the citrus sections of that county. It occurs in such abundance in some groves there that, on account of the weakening effect on the tree, fruit production has fallen off as much as 50 to 75 per cent. Fumigation and scale control was unknown in that county until the present year, but during this season a very general inauguration of such measures has been made. Excepting in a few localities, the infestations in southern California are not so severe as in the San Joaquin sections. The further fact that this scale is susceptible to fumigation for so short a period makes it an important economic factor in the citrus industry of California.

Aside from the general economic differences between this species and *C. hesperidum*, the life-history and habits differ in the two species. *C. citricola* always deposits eggs which may hatch immediately or after a day or two. In *C. hesperidum* the young are brought forth alive. There are several generations a year of *C. hesperidum*, while there is but one or a partial second in the case of *citricola*. Many of *hesperidum* may mature on the leaves, while *citricola* invariably migrates back to the twigs.

The young of *C. citricola* began to appear in 1914 about April 20 and continued until August. They settle on the leaves almost entirely, and mostly on the under side. In November and later they migrate back to the twigs. During the summer, fall and winter, they grow but little but rapidly mature in the early spring. The first molt occurs approximately one month from birth and the second molt a month later.

The following identified species of parasites have been reared from this scale: *Coccophagus lunulatus* How., *C. lecanii*, *C. flavoscutellum* How., *Aphycus* near *flavus*. One or two others are not yet identified.

A peculiarity in the control of this species is that it becomes very resistant to fumigation after early in September. No evident changes in the scale itself have been noted at this period. The black scale and others at the same size would be very readily killed by fumigation. Spraying has not proved to be very satisfactory, as is the case of all spraying for scale insects on citrus trees. Fumigation, between July 15 and September 15, has proved satisfactory, and is the treatment recommended.

OBSERVATIONS ON THE OVIPOSITION OF CERTAIN CAPSIDS[1]

By Harry H. Knight

The scarcity of knowledge in regard to oviposition by members of the family Capsidæ led the writer to undertake observations on those species of greatest economic importance in Genesee County, N. Y. During the past summer the following species were observed and their method of oviposition studied in detail: The Apple Red Bug (*Heterocordylus malinus* Reut.); False Apple Red Bug (*Lygidea mendax* Reut.); False Tarnished Plant-bug (*Lygus invitus* Say); and *Paracalocoris colon* Say.

While working in the field in coöperation with the Genesee County Fruit Growers' Association, the writer has had an unusual opportunity to observe these capsids over a large extent of territory. During the present year (1914) the Apple Red Bugs have proved to be among the most injurious insects attacking the apple in western New York. The rapid development of both species as pests has been quite remarkable. Described as new species in 1909 and life histories studied for purposes of control the same and following years (1911), such has been the brief history of these pests. It has been supposed that the apple red bugs were native to the hawthorn and wild crab and from these came over to the cultivated orchards. This theory is well supported by recent observations made in the field. On June 18, 1913, seven nymphs and some adults of *Lygidea mendax* were collected on *Cratægus* sp. in an old pasture near an apple orchard where the species was likewise abundant. Nymphs of both species were found abundant on hawthorn, wild crab, and wild apple trees May 24, 1914, at Portage Falls, in the valley of the Genesee River. Characteristic injury caused by feeding on the tender leaves and shoots was noted on all of these plants. This locality forms a natural and isolated breeding place for both species with no cultivated orchards within a radius of two miles.

The Apple Red Bug (*Heterocordylus malinus* Reut.)

The eggs of both species (*H. malinus* and *L. mendax*) and places where they are found have been described by Prof. C. R. Crosby (1911) in an excellent bulletin on these insects. No observations are recorded giving the time and manner of the deposition of the eggs. The first adult of the apple red bug (*H. malinus*) was taken June 7 but the majority of the species matured about June 12. Daily observations were made on the adults confined in cages and under natural

[1] Contribution from the Department of Entomology of Cornell University.

conditions on the trees. By June 19 many females were noted to be heavy with eggs but none were observed to oviposit until June 21. For purposes of photography the females were caged on suitable apple branches under large glass cylinders. The best results were obtained by keeping but one female in a cage. On the morning of June 23, four different females were observed while ovipositing. When a female is ready to oviposit she moves up and down the branch patting the surface with her antennæ and touching the wood here and there with the tip of the proboscis. In this manner one spent six minutes searching for a place to oviposit. Another individual required fifteen minutes before a suitable place was found. The female begins to drill the hole by means of the proboscis (Fig. 1, pl. 11). This operation may require from five to eighteen minutes before the hole is ready for the insertion of the ovipositor. After drilling the hole with the beak, the female arches the abdomen, stands as high as possible, then unsheaths the ovipositor and thrusts it forward to locate the place prepared (Fig. 2, pl. 11). The head is turned under with the tip of the proboscis in the hole to help guide the ovipositor. Even with this assistance the insect is not always successful. One female was observed to make seven attempts before inserting the ovipositor. Most individuals make two or three attempts before succeeding. After each failure, the hole is inspected and worked upon for a time with the beak. Once the ovipositor is started, the abdomen is worked up and down with a rapid jerky motion until the ovipositor is inserted nearly to its base (Fig. 3, pl. 11). An alternate contraction and expansion of the abdomen then occurs while the egg is being worked down into position. This operation requires about two or three minutes. The ovipositor is then withdrawn and a rest of three to five minutes follows before inserting the second egg. After this interval, the hole is again located by means of the antennæ and beak and then the operation of inserting the ovipositor is repeated. In some cases only one egg was laid in a place but two eggs appear to be the normal number. In one instance a female laid two eggs in each of three holes which were close together. All these eggs were placed in a line forming a ring at the junction where new growth started in the spring from a terminal twig (Fig. 6, pl. 11). Another favorite place is at the base of a new fruit spur. Figure 5, pl. 11, shows how such a spur was broken out and two eggs left exposed. The eggs are slightly curved and follow the cambium layer without penetrating the solid wood.

On June 21 seven females of *H. malinus*, apparently in an egg-laying condition, were captured on hawthorn at Portage Falls, N. Y. These were brought to the insectary and placed in cages on suitable apple branches. Two of these females were observed to oviposit on June

23. On the morning of June 24, one individual was photographed while ovipositing on apple. This female was then placed on a branch of *Cratægus* sp. and other photographs were obtained the same afternoon (Fig. 1, pl. 11). Thus it is seen how easily the species may go from hawthorn or wild crab to the cultivated apple.

The number of eggs laid varies with the individual from day to day. One female was observed to oviposit in six different places between 10.00 a. m. and 12.00 o'clock noon. This same female was observed to oviposit daily from June 23 to June 27, but died on the 28th. One female captured June 21 and kept in a cage was observed to oviposit as late as July 5 but was found dead on the 7th. Several females were captured July 5 on Cratægus and wild apple trees near Attica, N. Y. The wild fruit showed characteristic red bug injury as seen in cultivated orchards (Fig. 11, pl. 12). Two females heavy with eggs were captured on quince, July 11, at Byron, N. Y. Characteristic injury was observed on the quince fruit. Four females were taken on *Cratægus* sp., July 13, near Batavia. One of these individuals lived in the insectary until July 17. No more specimens were taken after this date.

False Apple Red Bug (*Lygidea mendax* Reut.)

Lygidea mendax matures from seven to ten days later than *H. malinus*. The first adult was captured on June 14 but the majority of the species matured about June 20. Several females were watched closely but no eggs were obtained until July 8. The adults may be seen to feed on the branches with proboscis deeply inserted for several minutes at a time. These holes are never used for inserting eggs. When ready to lay, the female moves about over the twigs searching for lenticels on wood of the previous year's growth. Several of these may be tested with the tip of the beak before one is selected for ovipositing. The behavior of this species is very similar to that of *H. malinus*. The lenticel is drilled out by means of the proboscis. One female required ten minutes for this operation. Three attempts to insert the ovipositor failed but on the fourth she succeeded (Fig, 4, pl. 11). It took two and one-half minutes to lay the egg. After an interval of four minutes, she returned to the hole and upon the second trial inserted the ovipositor and laid an egg. After this the wound was sealed by means of the proboscis. The lenticels are normally light colored but after being injured by the process of oviposition, they appear reddish brown. By this means one soon learns to locate those containing eggs. The normal number of eggs laid in a lenticel is two but in seven cases only one egg was found (Fig. 7, pl. 11). The eggs are placed in the cambium at such an angle that the lower ends may rest on solid wood and their tips be 1.5 mm. apart.

In order to get pictures of the bugs laying eggs, it was found that time could be saved by caging them for two days on leaves only, and then placing them on suitable branches before the camera. They are usually ready and anxious to deposit eggs by that time.

Females were observed ovipositing on the trees as late as July 18. Specimens were still on the trees July 22, but most of them disappeared with the cold rains that followed. A search was made on July 27 but no specimens were obtained on trees where they had formerly been abundant. This species was found numerous on hawthorn and wild crab along with *H. malinus* at Portage Falls, N. Y. The species has also been found breeding on quince trees.

The False Tarnished Plant-Bug (*Lygus invitus* Say)

This Capsid causes serious injury to pears, and is well described in a bulletin by Parrott and Hodgkiss (1913). The nymphs of this species have been found abundant on pear branches where they injure the fruits, but no records exist giving the time when eggs are laid or where they are placed.

This species is perhaps the most difficult in which to observe oviposition of eggs. Several females were kept in cages on pear branches but only one individual was observed to oviposit. This observation was made on the morning of June 26. Other females which were heavy with eggs were observed daily to feed on pear fruit and on the branches but no effort was made to oviposit. The female observed to oviposit was first discovered when the ovipositor was inserted nearly to its base in a fresh pear shoot of the present year's growth. After two minutes, the ovipositor was withdrawn. The female turned, inspected the hole, then moved along the branch about two inches. After five minutes, she became very active and proceeded along the branch feeling with antennæ and beak. She soon returned to the spot where eggs had been placed before, and with proboscis to mark the opening, she raised up, unsheathed the ovipositor and made the insertion much in the same manner as observed in the case of apple red bugs. A period of two minutes elapsed before the ovipositor was withdrawn. Upon examining the branch, it was found that six eggs had been laid in a space 1 mm. long. The eggs were closely packed in a double row lying flat just within the cambium layer (Fig. 8, pl. 12). Three of the eggs were injured in opening the cavity, thus they do not show well in the photograph. Of two eggs measured, the length is 1.05 mm. by .26 mm. wide.

The nymphs and adults of *L. invitus* were found most abundant on a row of Bartlett pears very close to a hedge-row of young elms and black locust. On June 5, the nymphs were found on both the pear and elm branches. Adults were reared from nymphs captured on the

elm shoots. On June 25, adults were quite numerous on both elm and pear trees. A search was made on the elm branches to see if eggs were being deposited there. One capsid egg was found inserted in the tender bark, which in size and appearance corresponded to that of *L. invitus*.

On June 20, two females and one male were placed on pear branches within a cheesecloth cage. The male died about the middle of July, while the two females were alive on August 6, but dead on August 8. No eggs were found in the branches. These adults produced characteristic injury to a pear growing within the cage.

An Apple Capsid (*Paracalocoris colon* Say)

This is a species which was found rather commonly on apple trees during the past summer. The brownish-red and white banded nymphs may be found feeding on the tender shoots and foliage in a manner similar to apple red bugs. However, the fruits which are punctured do not develop such deformities and scars as result from feeding by red bugs. The first adult was taken June 15. Oviposition was first observed on July 3. This species oviposits in places quite different from any capsid heretofore observed. The females prefer to oviposit along the margin of dead wood, such as stubs caused by the breaking off of limbs. Females which were caged on limbs free from scars did not oviposit. Three individuals were induced to lay by placing them on branches which had broken stubs (Fig. 10, pl. 12). One female was observed to oviposit on the tree. In this case, the egg was placed in the margin of a wound caused by the splitting off of a small branch. The female prepared a place in the margin of the live bark by means of the proboscis. The ovipositor is then thrust forward and worked into place with a rapid jerky motion. It requires from three to four minutes to insert the ovipositor and lay an egg. Five eggs were placed around the margin of one stub, a new hole being made for each egg (Fig. 9, pl. 12).

The egg is 1.2 mm. long by .2 mm. in width. It differs from other Capsid eggs by having a white cap with two keels that curve up and nearly meet over the top of the egg (Fig. 13). The cap projects from the cavity as shown in the figure, but is not conspicuous due to the uneven character of the rough bark and surrounding wood. Most of the eggs were deposited during the first two weeks in July. The last specimen captured was a female taken on July 28.

Fig. 13. Egg of *Paracalocoris colon* showing the cap with keels.

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PLATE 11

Fig. 1. *Heterocordylus malinus* drilling with proboscis, preparing to oviposit in Cratægus.
Fig. 2. *H. malinus* inserting the ovipositor.
Fig. 3. *H. malinus* with ovipositor inserted nearly to the base.
Fig. 4. *Lygidea mendax* with ovipositor inserted in lenticel.
Fig. 5. Two eggs of *H. malinus* laid at the base of a new fruit spur.
Fig. 6. Showing holes made by *H. malinus* in ovipositing at the junction of new growth and the old twig (enlarged).
Fig. 7. Bark removed to show egg of *L. mendax* (enlarged).

PLATE 12

Fig. 8. Eggs of *Lygus invitus* as deposited in pear branch (x2).
Fig. 9. Bark removed to show egg of *Paracalocoris colon* laid at base of dead stub.
Fig. 10. *P. colon* at the point of ovipositing.
Fig. 11. Natural fruit showing red bug injury.
Fig. 12. Cratægus leaves showing typical red bug injury.

COTTON SEED OIL SOAP AS A SUBSTITUTE FOR WHALE OIL SOAP[1]

By W. W. YOTHERS, *Bureau of Entomology, Orlando, Florida*

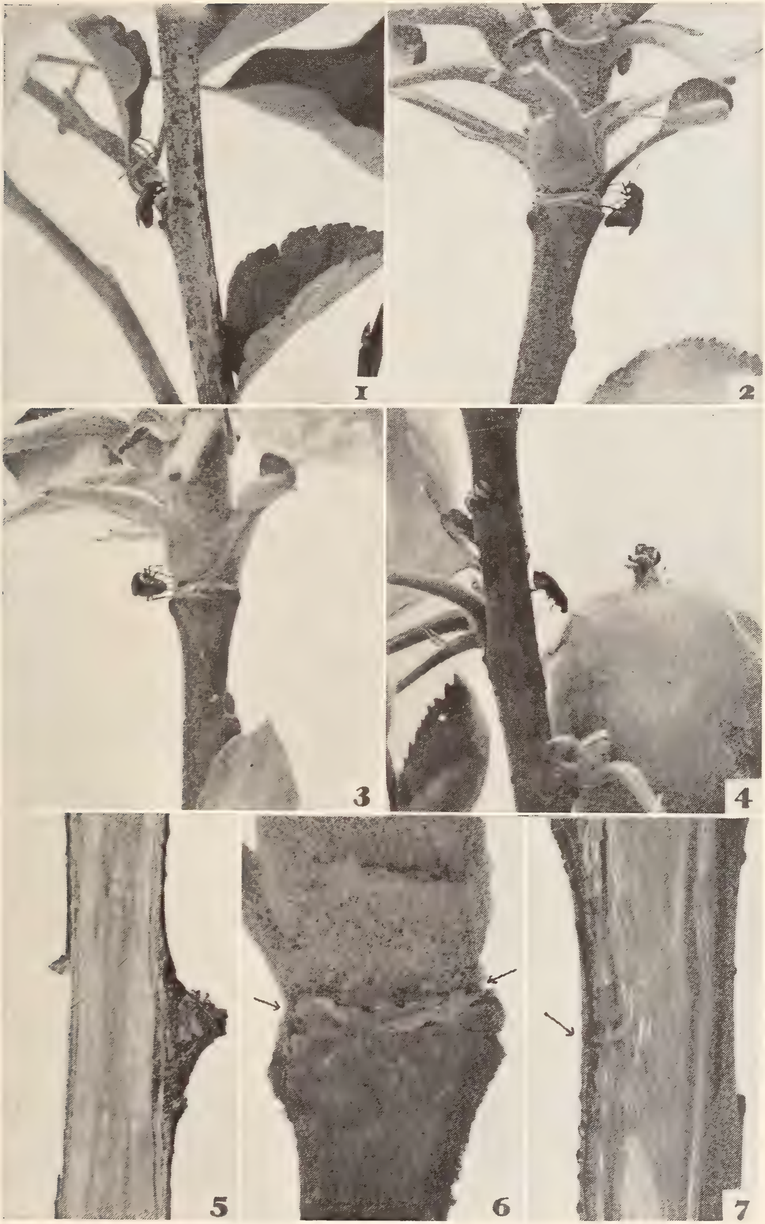
Many people, including some entomologists, find the odor of fish oil soap very disagreeable. Especially is this the case if it is used on plants in a conservatory or greenhouse. With a view to finding a substitute for whale oil soap much experimenting was done with cotton seed oil and the following formula was originated:

2 quarts of cotton seed oil,
6 ounces of caustic potash,
1 quart of water.

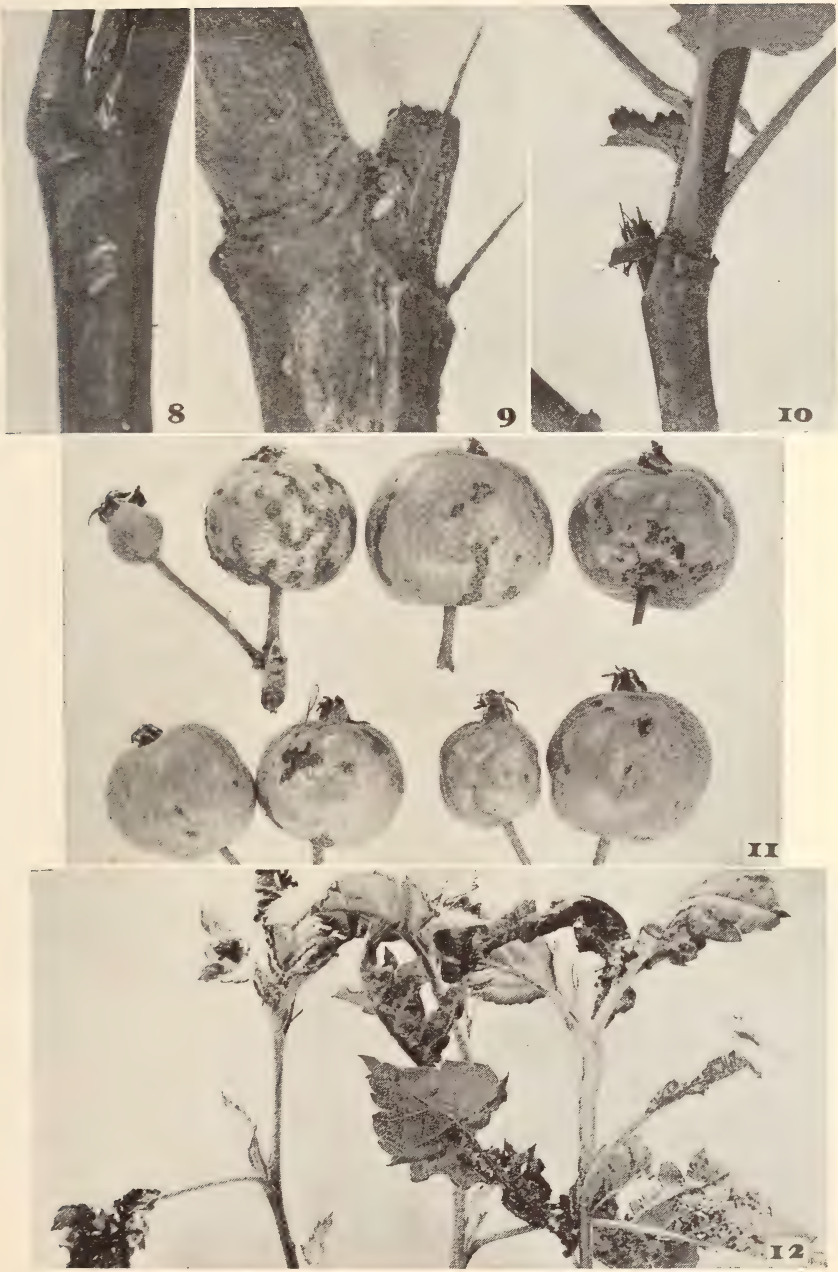
Directions: Dissolve the caustic potash in the water and heat until it boils vigorously. The oil then should be added very slowly. It should be added in such a way that the boiling should not cease. A few minutes after all the oil has been added the soap is finished. Stirring, of course, must be continued throughout the process.

This formula contains $63\frac{7}{10}$ per cent of oil, $31\frac{8}{10}$ per cent of water and somewhat less than 6 per cent of caustic. The product has about the same consistency as ordinary fish oil soap and is quite easily handled.

[1]Published by permission of the Chief of the Bureau.



Capsid oviposition



Capsid oviposition

About two years after this work was done it was found that this is about the regular formula for the manufacture of soft soap from cotton seed oil, as given in various publications. This formula can also be changed so that it will contain from 43 to 50 per cent of oil and the product resulting will be quite satisfactory.

The experiments so far indicate that this soap can be used as a substitute for fish oil soap and we would recommend that entomologists try this for greenhouse plants and other plants where the people object to the odor of fish oil soap.

REARING OF MOTHS AND TACHINA-FLIES FROM LARVÆ AND PUPÆ OF ARMY-WORM IN NORTH CAROLINA IN 1914

By Franklin Sherman, Jr., *Entomologist, State Department of Agriculture, Raleigh, N. C.*

In Vol. 1, p. 354 of this Journal, Prof. Z. P. Metcalf gives data on parasitism of army-worm (*Heliophila unipuncta* Haw.) by the Tachina-fly (*Winthemia 4-pustulata* Fabr.). His data was secured from worms collected during an outbreak at Durham, N. C., in August, 1908.

On July 29, 1914, the writer, with Mr. C. L. Metcalf, collected many army-worms (*H. unipuncta*) near Neuse, N. C., thirteen miles north of Raleigh. These were sorted into lots according to the number of parasitic eggs we could detect on each worm, and rearings were made (1) by placing numbers of similarly parasitized worms in the same cages and (2) by placing individual worms in separate vial-cages.

All cages had one to three inches of moist sifted earth, and plenty of fresh grass supplied so long as needed. Examinations were made almost daily while developments were taking place. From the way in which healthy worms fed and grew I believe that few died from the handling or artificial conditions, though the mortality was high even among those not apparently infested with insect parasites.

From 534 army-worms, showing 1,313 parasitic eggs, we reared a total of 18 adult moths and 296 parasitic flies, these representing 220 *Winthemia 4-pustulata* Fabr. (which was the only one reared by Prof. Metcalf in 1908), *47 Phorocera claripennis* Macq., and 4 *Goniomyia unifasciata* Desv., while 25 flies were mutilated, deformed and not identifiable (these were in all probability of the first two species named in this paragraph).[1]

It was found that the larvæ of *W. 4-pustulata* left the dead larval host and went deeper into the soil ($\frac{1}{2}$ to $1\frac{1}{2}$ inches) to form their puparia. In no case where this fly issued did the host form the pupa, though the

[1] Not taking into account a number of Sarcophagid flies which emerged in the larger cages.

occasional formation of the pupal cell was noted, and in every case the fly-puparia were found free in the earth. The same held true for *P. claripennis* so far as noted.

In cases where *G. unifasciata* was reared the host pupated and the fly-parasite emerged from the pupal host.

We have preserved in our collections one army-worm with 16 evident parasitic eggs—one with 17 eggs, and one with 34 eggs, these being the highest numbers found.

The rearings from the army-worms collected at Neuse, N. C., and which showed from 0 to 15 parasitic eggs per worm, are indicated in the following table.

Rearings from Army-worms from Neuse, N. C., 1914

Visible Parasitic Eggs per Worm	Worms	Moths Reared	Tachina-flies: Winthemia 4-pustulata Fabr. ♂	♀	Phorocera claripennis Macq. ♂	♀	Goniomyia unifasciata Desv. ♂	♀	Flies	Fly Eggs	Per cent Flies to Fly Eggs
0......	158	15	0	0	1	0	1	3	5		
1......	96	1	7	11	0	2	0	0	20	96	20.83
2......	76	0	19	17	1	4	0	0	41	152	26.97
3......	64	0	21	26	5	11	0	0	63	192	32.81
4......	36	1	12	22	3	3	0	0	40	144	27.77
5......	30	1	18	15	1	1	0	0	35	150	23.33
6......	24	0	8	12	1	1	0	0	22	144	15.27
7......	18	0	5	6	2	4	0	0	17	126	13.49
8......	14	0	3	5	1	1	0	0	10	112	8.92
9......	5	0	1	2	0	0	0	0	3	45	6.66
10......	5	0	0	2	1	0	0	0	3	50	6.00
11......	1	0	2	1	0	0	0	0	3	11	27.27
12......	3	0	0	1	0	2	0	0	3	36	8.33
13......	2	0	0	4	0	0	0	0	4	26	15.38
14......	1	0	0	0	1	0	0	0	1	14	7.14
15......	1	0	0	0	1	0	0	0	1	15	6.66
			96	124	18	29	1	3			
Totals.	534	18	220		47		4		271 +25*	1,313	
									296		

* 25 flies were deformed, mutilated, lost, or otherwise not identifiable.

It will be noted that from 158 worms, which bore no visible eggs, we reared 15 adult moths (less than 10 per cent) and that 5 flies, all but one of which were *G. unifasciata*, emerged. One moth issued from the worms showing one egg each, one moth from worms with 4 eggs each, and one moth from worms showing 5 eggs each. No moths were reared from 74 worms showing from 6 to 15 eggs each.

While admitting that the numbers involved are not large enough to furnish an absolute criterion, yet the per cent of fly-eggs which produced flies give some interesting suggestions. The mortality among the flies (from egg to adult) was less among those where there were 2 eggs per worm, than among those which had one egg per worm,—and the mortality was still less when there were 3 eggs per worm. This suggests that where there are only one or two eggs per worm, the worm may have sufficient vitality to prevent the development of the parasitic larva inside the host. The highest percentage of flies was secured where there were 3 eggs per worm, and from this we may argue that when the worm bears 3 eggs there are enough parasitic larvæ to more certainly kill the host before the larvæ perish inside and the parasitic larvæ can still find sufficient nourishment to mature. The per cent of flies maturing declines consistently when we pass above 3 eggs per worm until we reach 11 eggs per worm, but beyond this point the numbers involved in the rearings are certainly too small to warrant conclusions. Indeed, I feel that all above 8 eggs per worm are supported by too little data to warrant any real dependence being placed on them.

We often reared 2 adult flies from one worm, in several cases, 3 flies from one worm, and in one case we reared 4 adult flies (*W. 4-pustulata*, 1♂ 3♀) from one worm which showed 4 eggs when caged.

One worm showed 3 eggs July 29; on August 3d it was still active though two parasitic larvæ had certainly entered, yet the worm partially pupated and then perished, neither moths nor flies developing. In no case did we secure both a parasitic fly and an adult moth from the same worm, nor did Professor Metcalf note any such occurrence in 1908.

Rearings from Army-Worm Pupæ

While looking into an army-worm outbreak in Haywood County in the mountains of western North Carolina, I secured a lot of pupæ (not counted). From these we could not expect to rear *W. 4-pustulata*, or *P. claripennis* which leave the dead larval host. But we included a few separated fly-puparia which were found among the pupæ in the field. All were put in one cage. Result:

Army-worm Moths		23	
Tachina-flies	*Architas analis*, Fabr.	13	(6♂, 7♀)
	Goniomyia unifasciata, Desv.	10	(5♂, 5♀)
	Winthemia 4-pustulata, Fabr.	1♂	
	Phorocera claripennis, Macq.	1♀	

From the abundance of pupæ in the field in Haywood County it was evident that *W. 4-pustulata* and *P. claripennis* had not been so active in subduing the worms as they had been at Neuse, where we found

very few pupæ after the larvæ disappeared. Yet the fact that we reared a specimen of each from the stray puparia collected shows that both species had been present. These army-worm pupæ yielded as many flies as moths, approximately equally divided between *A. analis* and *G. unifasciata.*

These rearings and observations taken together with those of Professor Metcalf in 1908 indicate that *W. 4-pustulata* is the chief insect parasite of the army-worm in the central part of North Carolina, and that *P. claripennis* was also an appreciable factor in 1914. *A. analis* and *G. unifasciata* both killed many pupæ in western North Carolina in 1914.

Braconid and Ichneumon parasites (Hymenoptera) were noted or reared on only an insignificant percentage of the army-worms. Several predaceous enemies were noted in the field but in no case enough to be an important factor. We believe that bacterial diseases played a part, but secured no confirmation on this. The largest natural factor noted was the Tachina-fly family.

The indentifications are by Mr. H. E. Smith of the Bureau of Entomology, Washington, D. C., to whom I desire to express thanks.

RELATIVE SIZE IN FUMIGATION

By C. W. Woodworth

The measurements now always taken in obtaining the size of fumigation tents are the distance over the top and the circumference. Most tables now in use are incorrectly calculated because equal values have been given to both dimensions.

It will be evident at once that the distance over is changed with a change either in the height or the diameter of the tree and that therefore it is the more important of the two.

The possibility of adding to this dimension an amount dependent on the difference between the two measurements which will indicate the proportionate size of a tent gives us a new and very convenient and accurate method of rating a tree for dosage.

This we will call the "relative size" of the tent. If the proportions of a tent remained constant the distance over could then be taken as the relative size. Since the distance around always equals or exceeds the distance over we may select as standard a tent with these two measurements equal. The amount to be added to this to allow for wider and shorter tents is one fifth of the difference between the two measurements. Thus a tent 20 x 30 would have a relative size of 22 and should

have a dose equal to that of a tent 22 x 22. It will not be necessary to explain here why one fifth is the correct factor.[1]

The adoption of this plan of relative sizes makes it possible to present a table of dosage in an exceedingly simple form, and to make the adjustments for different degrees of leakage also very easy.

DOSAGE TABLE

Ounces of Sodium Cyanid

• Relative									Leakage		x		x		x			.25%		x			x			x	%	
Size		64	61	58	56	53	50	47	44	42	40	37	35	32	30	28	26	24	22	20	18	16	15	13	11	10	ft.	
40	36	32	28	24	20	18	16	14	12	10	9	8	7	6	5	4¼	4	3½	3	2½	2	1¾	1½	1¼	1	¾	½	¼

Relative size equals distance over the tent plus one for each 5 ft. of difference between the measurements.

Leakage more than .25% is read to the left and if less to the right, one number for each .05% more or less than .25%. Do not fumigate trees smaller than number of feet equal to .00% of leakage. *Holes* produce leakage requiring the use of the next number to the left when equivalent to a triangular tear half as many inches long as relative size and quarter as wide as long.

Stronger dosage for purple scale may be read one or two numbers to the left and

Weaker dosage for black scale one or two numbers to the right

Acid corresponding with any dose is given 2 numbers to the left and

Water 3 numbers to the left of the acid dose.

In the foregoing table the approximate size of the minimum dose is indicated by asterisks except for .25 per cent which is printed to emphasize that this table is for that degree of leakage.

The first line of figures gives the relative sizes corresponding with the doses on the following line. The intervals range from 1-3 and the dose intervals from ¼ oz. to 4 oz. This corresponds quite closely with previous tables and with actual practice.

The table in fact will be soon memorized. It will be noticed that the intervals of the upper line just above 10 and 15 are 1 and that other intervals are two except just below 35 and 40 and above 44. The doses corresponding to 10, 20, 30, and 40, are ¾, 2½, 5, 9, and with 64 is 32 oz. The intervals in the dose line are by quarter ounces to 2, half ounces to 5, ounces to 10, two ounces to 20 and four ounces to 40.

The acid and water dose is usually calculated mentally; if to be read from the table cut a card as wide as five numbers. Held against the table the two corners will indicate cyanid and water and a line on the card may be drawn to point to the acid dose. Or prepare a card by cutting out a hole or notch wide enough to enclose five numbers and have this line to indicate acid as before.

The mental effort in calculating the relative size will not be found to

[1] Bulletin 220, Cal. Agr. Exp. Sta., p. 5.

be difficult and is decidedly easier than the process of adding the two figures which is now done in obtaining the distance over.

A few examples will help in understanding the process. A tent 20 x 30 gives a relative size of 22 (difference 10 giving 2 to add to the 20) and the dose given on the table under 22 is 3 oz. 25 x 37 gives a dose a little over 27 and the dose of 28 which is $4\frac{1}{2}$ oz. would be correct.

Where the leakage is not .25 per cent or other factors enter into the calculation, the process is still very simple and easy. Thus with a .30 per cent, 23 x 28 tree, the dose would be 4 oz. instead of the $3\frac{1}{2}$ shown in the table based on a .25 per cent leakage.

Taking about the most complicated case—a 20 x 26, 15 per cent tent, with rents amounting to 10 sq. in., determine the weakest dose for black scale. The size would indicate 3 oz. and the dose would have dropped to 2 oz. because of the tight tent, but for the holes which moves the number to $2\frac{1}{2}$ and finally the weak dose for black scale drops it down two intervals to $1\frac{3}{4}$ which is correct under these conditions.

If one had in this case a .30 per cent leakage the tent should not be used because the relative size is less than 30 and efficient fumigation is not to be expected.

There can be no doubt that all these factors should be taken into consideration in fumigation if the best work is to be done and this dosage table may help to remove the difficulties which have hitherto seemed to the fumigators to be insurmountable.

THE USE OF WATER UNDER PRESSURE FOR THE CONTROL OF MEALY BUG[1]

By W. W. Yothers, *Bureau of Entomology, Orlando, Florida*

Owing to the ineffectiveness of spraying with insecticides for the control of mealy bugs in Florida it is interesting to know how a citrus grower controlled this pest successfully. These results were obtained by Mr. A. H. Brown, manager of the Atwood Grapefruit Company, Manavista, Florida.

This grove of more than 200 acres is fitted with a high pressure irrigation system throughout and hydrants are placed at intervals so that hose 100 feet long when attached will reach all the trees. The system furnishes about 60 pounds pressure. When used to control the mealy bugs a nozzle made out of three-fourth inch pipe three feet long is used. The end is flattened so that the aperture is about 1 inch wide and one-eighth of an inch opening. Since the mealy bug con-

[1] Published by permission of the Chief of the Bureau.

gregates largely where the fruits touch, the stream is directed at these places and the mealy bugs are knocked off on the ground. About three applications of this irrigation system is sufficient to control quite a severe infestation. This involves little extra expense since the water is usually needed in a grove.

In view of the extraordinary success of this instance, it is certainly advisable to experiment with water sprayed under pressure from the ordinary spraying machine. In view of the fact that as yet no insecticide will kill the mealy bug to any extent and no other system of spraying is a matter of record, to my knowledge, I think Mr. Brown deserves much credit.

ENTOMOLOGICAL MUSEUM OF THE UNIVERSITY OF KANSAS

The following is a tabulation of the number of species and specimens:

	Number of species varieties in regular named collections.	Number of specimens in regular named collections.
North American Coleoptera	8,089	35,052
" " Lepidoptera	3,756	12,208
" " Diptera	2,244	6,741
" " Hymenoptera	1,304	3,912
" " Hemiptera	1,064	3,724
" " Orthoptera	492	1,845
" " Neuroptera	293	
Exotic Coloptera	2,600	8,450
" Lepidoptera	981	1,716
Collections for studies in geographic distribution, variations and economic problems		190,000
Grand totals	20,803	263,640
Grand totals in Museum		284,451

Summary of Types in Snow Entomological Collections

Neuroptera	1
Orthoptera	15
Hemiptera	45
Coloptera	12
Diptera	490
Lepidoptera	100
Hymenoptera	259
African Diptera	25
Total	947

Scientific Notes

The Box Leaf Miner. There appeared in Newport in the spring of 1912 an insect which threatened to be disastrous to the shrub known as boxwood. My attention was first called to it when it was in the larval form in May. I recognized this insect at once as a miner and endeavored to find out its life history, but being unable to do so I have studied it with the following results:

Beginning in May when the insect first seemed to gain life in the leaf, I watched it grow until the first of June when it appeared to eat its way through the leaf and little flies dropped to the ground, where, after struggling for a few moments suddenly became possessed of wings and flying around at a distance of but a few feet from the plant, soon mated and as near as I could tell seemed to lay their eggs in the upper epidermis of the leaf. This went on for about six days when the flies suddenly disappeared and I found large numbers of them on the ground apparently dead, and I came to the conclusion that the male, after copulating, had died and the females after laying their eggs had followed the same course. This was all that I saw of the insect until about the 15th of August when little wart-like protuberances appeared on the leaves and upon examination I found very small larvæ again working there. I paid very close attention, as I thought perhaps within a few weeks there would be a new brood hatched, but I was somewhat dismayed when, after waiting for a couple of months, I found that there was no new brood of flies but that the larvæ had gone into winter quarters.

Being thus assured of the life history of the insect I endeavored to attack it by means of fumigation in the early spring, but failing in this I waited for the flies to appear in June when I prepared as many as a dozen different contact sprays to kill the insect when it appeared in its adult form. We sprayed the flies every other day, making a total of three sprayings, and of all the sprays which I used there was none which gave the immediate satisfaction as did that of soluble sulphur in the powdered form, which I used at the rate of four pounds to fifty gallons of water. This was the most effective spray which did not injure the plants and has worked successfully on all estates where used.

H. C. Walker.

Conference of Officials engaged in Gipsy Moth Work. On February 13, 1915, a conference of officials engaged in gipsy moth work was held at the Boston office of the Bureau of Entomology for the purpose of discussing gipsy moth conditions in order to secure as much uniformity of work and general coöperation as possible among those engaged in this project.

Dr. L. O. Howard, chief of the Bureau of Entomology, presided at the meeting and the following officials and visitors were present:

Dr. C. Gordon Hewitt, Dominion Entomologist, Ottawa, Canada.
Mr. L. S. McLaine, Assistant in Gipsy and Brown-tail Moth Work, Ottawa, Canada.
Hon. W. T. Guptill, Commissioner of Agriculture, Augusta, Me.
Mr. E. J. Cady, Special Agent in Charge of Gipsy Moth Work, Portland, Me.
Hon. A. L. Felker, Commissioner of Agriculture, Concord, N. H.
Prof. W. C. O'Kane, Deputy Commissioner, in Charge of Moth Work, Durham, N. H.
Mr. Harold L. Bailey, in Charge of Suppression of Insect Pests, Bradford, Vt.
Dr. H. T. Fernald, State Inspector of Nurseries, Amherst, Mass.

Prof. A. E. Stene, State Entomologist, Kingston, R. I.
Mr. C. W. Loveland, Assistant Entomologist, Providence, R. I.
Dr. W. E. Britton, State Entomologist, New Haven, Conn.
Mr. I. W. Davis, Assistant Entomologist, New Haven, Conn.
Dr. T. J. Headlee, State Entomologist, New Brunswick, N. J.
Mr. Philip B. Ayers, Secretary of Society for the Protection of New Hampshire Forests, Boston, Mass.
Mr. E. L. Reynolds, Secretary of Massachusetts Forestry Association, Boston, Mass.
Mr. C. B. Williams, Mr. Ernest Hargreaves, and Mr. George H. Corbett, Carnegie Scholars, who are studying problems in Economic Entomology in this country; and a number of representatives of the Bureau of Entomology engaged in all different lines of investigation and field work which are being carried on in connection with the gipsy moth project.

Other officials having charge of moth work in Massachusetts, New York, and Ohio, were not able to be present at the meeting.

The meeting was called to order by Dr. Howard and a statement was given by representatives from each state and the Dominion of Canada concerning the existing conditions and the methods which were being used to control both the gipsy and brown-tail moths.

This was followed by a brief statement by Dr. Howard, in which he indicated that Federal work on these two insects had been brought about largely because of the fact that the states infested were attempting to control these insects. He further stated that there seemed to be little disposition on the part of Congress to discontinue appropriations so long as it could be shown that the states were doing their part in stamping out these pests.

Statements were then made by members of the Federal gipsy moth force in regard to the different lines of work which were being carried on and the results which have been accomplished.

The parasite and other experimental work was briefly outlined by the writer, and the sylvicultural work, scouting work and quarantine work, was discussed by Messrs. Clement, Worthly and Rogers.

At the afternoon session a general discussion was taken up in regard to the desirability of more uniform legislation in the different states and suggestions were made relative to changing some features of existing laws so as to bring about better results. Sufficient time was available, so that different men in attendance had an opportunity to discuss features of the work in which they were most interested, and it was the opinion of those present that much benefit and a better understanding of conditions in different parts of the infested territory would result.

During the conference it was brought out that a change in the gipsy moth quarantine regulations was pending and that the Federal Horticultural Board expected to permit the shipment of Christmas trees and Christmas greens in the fall of 1915, after they had been inspected. The present regulations do not permit the shipment of material of this sort outside the areas under quarantine for the gipsy moth. It was the opinion of those present that Christmas trees and greens could not be satisfactorily inspected, owing to the large amount of material which is moved in a short period of time.

On motion of Dr. Hewitt, the thanks of the meeting were extended to Dr. Howard and the writer for calling the meeting and it was voted to hold a similar meeting next winter.

A. F. Burgess.

Juniper Plant Bug (*Chlorochroa uhleri* Stal.) This large, olive green stink bug with pinkish markings is easily recognized and usually rare, though in June, 1894, it was reported from Brockport, N. Y., as having nearly destroyed a crop of peaches. Several years ago we found some eight or ten of these bugs on a small pine tree at North Chatham, and the past summer reports of the unprecedented abundance of this insect, accompanied by serious injury, were received from Mr. M. A. Soule, Quaker Street, Schenectady County, N. Y. Mr. Soule states that the bugs were thick on sunflower seeds, that they injured green corn and destroyed small peas while still within the pods, the insects evidently piercing the pods and drawing the sap direct from the seeds, and in this way preventing a normal development. Tomatoes were also injured and turned black at the point of attack within a few days. Quantities of currants and berries were likewise spoiled.

Mr. Soule kindly forwarded a number of living bugs and we were able to verify the reports so far as corn and tomatoes were concerned. The insects repeatedly established themselves upon the surface of a tomato, and after a time the slender, chitinous lancets were forced into the fruit to their full extent, the ensheathing labium folding back near its middle as the head was pushed down until its lower margin touched the surface of the fruit. One bug remained over a feeding puncture twenty-seven minutes, repeatedly raising and lowering its head as it partly withdrew or forced the lancets into the fruit. When the latter occurred the lancets were supported only by the tip of the labium and the tissues which they pierced. The next day the fruit showed an oval, slightly sunken area about a quarter of an inch in diameter, the center being marked by a minute puncture. This injured spot became more visible the second day, and later exhibited some discoloration. A similar injury was also observed to kernels of sweet corn in the milk.

The Juniper plant bug was by far the most abundant species concerned in this injury, though the related *Euschistus variolarius* Pal. Beauv. was present in much smaller numbers and was observed feeding upon both corn and tomatoes. This latter insect apparently experienced less difficulty in piercing the skin of the tomato, though it did not drive the lancets so deeply into the fruit as to necessitate the folding of the labium.

E. P. Felt.

A Cricket Predaceous on the Termite. While observing a flight of termites (*Termes lucifugus* Rossi) at Manhattan, Kansas, on October 6, 1914, the writer noticed a common field cricket (*Gryllus pennsylvanicus* Burm.) feeding on the termites as they emerged from the ground. The cricket was between two of the holes from which the termites were emerging and was devouring one termite after another. During the fifteen minutes that the cricket was under observation it caught and devoured eleven termites.

J. W. McColloch, *Manhattan, Kansas.*

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

APRIL, 1915

The comparative uselessness, so far as many complaints of insect depredations are concerned, is apparent to practical entomologists, because all too frequently the presence of a pest in numbers is not recognized until most of the damage has been done or it is too late to accomplish much in checking the trouble. In some instances preventive measures should be adopted months before the outbreak occurs, and frequently the probabilities are against a recurrence of the trouble in the locality the next season. And, even if the latter were the case, there are many chances against the adoption of timely and effective control measures. These well-known conditions lead us to raise the question as to the responsibility of the practical entomologist. Is there not an obligation upon him to forewarn his clientage of a probable danger and the best methods of meeting the situation? If this be true, and few will dispute it, have economic entomologists discharged their full duty in this respect? We admit that forecasting insect outbreaks has its perils and all statements of this character should be most carefully qualified. It is frequently possible to make positive statements respecting the probabilities of the next season or the next few months, and, while this is often done in the case of a few insects, we are by no means certain that entomologists have lived up to their opportunities systematically. There is a constantly increasing literature on insect outbreaks and their causes, and special studies along this line may well be ranked as among the most practical investigations. This data should be used wherever there is an opportunity and the American public trained to take advantage of the "advance" information available. Control before serious damage has been caused is an infinitely better proposition than destruction of pests after half the crop has been ruined. The value of preventive measures

can hardly be emphasized too strongly. Next to that, we may well dwell upon the preliminary signs of insect outbreaks in an effort to accustom agriculturists to correctly interpret local conditions, especially in relation to unusual depredations. The usual, annual pests are as a rule fairly well controlled. There is relatively greater loss from insects which occasionally become very destructive, largely because someone fails to appreciate the significance of the preliminary signs. The entomologist cannot hope to be in all sections of his territory. He usually can have some type of fairly competent observers in important localities and such parties, if possible, should be well posted along these lines, and promptly report all suspicious developments.

Reviews

The House-Fly, *Musca domestica* Linn., **Its Structure, Habits, Development, Relation to Disease and Control,** by C. Gordon Hewitt. University Press, Cambridge, 1914, pp. i–xv, 1–382, figs. 104.

This exhaustive and valuable study of one insect is the outcome of investigations continued over a series of years and is "primarily intended for the use of entomologists, medical men, health officers and others similarly engaged or interested in the subject." It is a detailed anatomical, biological and ecological study of an insect, duly correlated with the investigations of others, for the purpose of establishing a substantial basis for practical control work. A portion has been published earlier, but, as pointed out by the author, the advances of recent years have been so great as to necessitate the rewriting of the entire work. Aside from the very full account of the house-fly, other species occurring in houses are briefly noticed and their characters in both larval and adult stages given. The pathogenic phase, a most important subject, is considered in detail and occupies about 100 pages; chapters in this part dealing with the dissemination of pathogenic organisms by flies, the carriage of typhoid fever, the relation of flies to summer diarrhœa of infants, the dissemination of other diseases, etc. The most approved control methods are summarized in chapter 26. The author's personal knowledge of both English and Canadian conditions enables him to discuss the matter from an unusually broad standpoint. The illustrations are excellent, the colored figures being particularly good.

A bibliography of 37 pages indicates the ground which must have been covered in the preparation of this work, not to mention the original studies of the author. Both scientist and layman are indebted to this investigator for placing the information regarding this most dangerous insect in such convincing and convenient form. The volume is indispensable to all desiring detailed information—a prerequisite to the successful control of this pest.

Handbook of Medical Entomology, by Wm. A. Riley and O. A. Johanssen. Comstock Publishing Company, Ithaca, N. Y., 1915, pp. i–x, 1–348, figs. 174.

The developments in medical entomology have been so rapid and the subject is of such vital importance, as to amply justify the preparation of this volume, a work designed to "afford a general survey of the field, and primarily to put the

student of medicine and entomology in touch with the discoveries and theories which underlie some of the most important modern work in preventive medicine." This volume is written by entomologists possessing a keen appreciation of the applied or medical aspects of the subject, a viewpoint, we believe, essential to the most successful prosecution of investigations along this line.

The first chapter gives a brief historical survey of the early suggestions regarding the transmission of disease by insects. The next contains a somewhat detailed discussion of forms directly poisonous to man, that relating to spiders, ticks and stinging insects being particularly interesting and demonstrating in a convincing manner the errors sometimes characteristic of popular beliefs. About 60 pages are devoted to species parasitic on man, ticks, lice, mosquitoes and fleas—all represented by one or more important disease-carriers, which latter receive special attention.

The dissemination of disease by insects and their allies—the foundation of medical entomology—is discussed in its various phases in chapters 5–11, a total of about 100 pages. The more important disease-carriers are somewhat fully treated in this portion of the work; house-flies, fleas, mosquitoes, tsetse flies, and their relations to diseases indicate a portion of the field covered.

The necessity of identifying noxious forms has been met by tabulations of the characters of dipterous larvæ most likely to be encountered (p. 136), of flies frequently mistaken for house-flies (p. 145) and of hominoxious arthropods, chapter 12. This feature and the extended and well selected bibliography add greatly to the value of the volume, especially for the investigator. There is a large series of excellent illustrations.

The subject is world-wide in application, vital in interest and the authors, by painstaking study and investigation, have produced a work which must be extremely serviceable to an extended cliental.

The Apple Maggot, By W. C. O'Kane, New Hampshire Agricultural Experiment Station, Bulletin 171, pp. 1-120, 1914.

In this large bulletin Professor O'Kane has given us the results of a long and careful study of an important pest. It is evident that no pains have been spared to make the investigation thorough, and in consequence a great deal of valuable new data has been obtained. The bulletin is written in a clear, simple, concise style. It is illustrated by two maps, sixteen photographs, one drawing and several charts of orchards used in the experiments. Most of the photographs are good, but a few are of an inferior character. Considering the comprehensive nature of the work and the value of good figures, one feels that it would have been an improvement if more good illustrations had been added representing the various stages of the insect, either natural size or both natural size and enlarged.

The bulletin begins with a good summary of contents. This is followed by an excellent account of the early history, food plants, distribution and destructiveness of the pest in North America. Then comes a discussion of its economic importance in New Hampshire. The remaining eighty-five pages are devoted to an elaborate account of the life history and habits of the insect, natural enemies, control experiments and recommendations for control. The last four pages contain a good bibliography.

The subject-matter throughout has been well handled and due attention given to each phase, except that it would probably have been better if another paragraph or two had been added giving a more detailed account of the nature of the injury done by the insect and the manner of distinguishing this from the injuries of other apple insects or from the Bitter Pit disease, which is so frequently mistaken by fruitgrowers for it.

Of the many valuable data given, the following are some of the most interesting and important, either as new contributions or confirming the conclusions of earlier investigators.

The flies begin to emerge in New Hampshire some years as early as the last week in June. The maximum emergence is reached the second and third weeks in July and emergence is practically at an end by the middle of August. Egg-laying extends from early July to the latter part of September. Adults may begin to oviposit inside of a week. (It had hitherto been supposed that two weeks or at least ten days was the minimum time between emergence and oviposition.) Efforts were made to determine the average length of time before oviposition but were unsuccessful. This was due to the difficulty of getting adults to act normally in any kind of cage devised The same difficulty made it impossible to determine either the average or maximum length of life of individuals under normal conditions. There is only one brood a year in New Hampshire. (Illingworth has reported two from New York.) Eggs hatch in from five to seven days. There is a very high mortality of eggs or larvæ or both in all kinds of fruit. This is least in early apples and greatest in winter varieties, in the latter case often reaching to 100 per cent. Larvæ do not leave the fruit, except in rare instances, until after it falls and has become mellow. The maximum issuance of larvæ occurs from infested fruit dropping early in the ripening season. Some of the factors that determine the degree of infestation of one variety compared with another are: early ripening, aroma, and thickness of skin. These factors may act separately or in combination. A small percentage of pupæ do not emerge at the ordinary time but remain two winters in the soil, thus making a two-year cycle. This tends to some extent to complicate control measures. Soil fumigants can scarcely be relied upon as a practicable or effective means of control. Cultivation does not control or have any noteworthy effect on the insects. Pupæ cannot in orchard practice be buried deeply enough to prevent emergence. Firming the soil would seem to be impracticable as a means of control. Poultry are helpful but usually are not available in sufficient numbers. No kind of bait has been discovered that appreciably attracts the adults. Sweetened poisons sprayed on the trees give very little indication that they can be relied upon to control the pest. The one great remedy is the destruction of infested fallen fruit before the larvæ can escape. The fact that the larvæ will not emerge until the fruit is mellow and that the great majority come from early ripening fruit simplifies this means of control. Barnyard stock, especially sheep, hogs and cattle, may be utilized in the destruction of this fruit.

Such are some of the most important conclusions reached in this bulletin. The evidence on which they are based seems in almost every case to be satisfactory. However, on the question of the value of spraying with sweetened poisons there is room for doubt whether this method was given a fair test. It is clear that the author felt satisfied that all the necessary conditions for such a test had been fulfilled. A careful perusal of his experiments will show, however, that in no case was nearly all or even half of an orchard sprayed, but only from one to three trees, and these were, so far as can be learned, never farther than fifty yards distant from unsprayed trees and usually much nearer. The experiments were planned evidently on the assumption that the flies for the most part do not travel much through the orchard before beginning to lay eggs or later. In our work on Cherry Fruit-Flies we at first tried this same manner of testing the sweetened poison with the same belief about the habits of the flies, but soon found that no satisfactory results could be obtained unless we sprayed almost all the orchard. Once this discovery was made we were able to take the worst infested orchards in the province and almost exterminate the pest in them. As the habits of Cherry Fruit-Flies are very similar to those of Apple Maggot Flies, we

are of the opinion that the sweetened poison spray should not be considered a failure against the latter pest until it has been tested under different conditions. The best test, we believe, is to choose two isolated orchards, both badly infested the previous year, and treat them alike in all respects, except that the one shall receive at least three applications of sweetened poison (2 or 3 lbs. arsenate of lead to 50 gals. water, sweetened with 1 gal. of cheap molasses), the first application to be made as in Professor O'Kane's experiments, as soon as the earliest flies appear, and the others at intervals of about 10 or 12 days. Both the upper and under surfaces of the leaves should be covered to prevent the mixture being all washed off by heavy or prolonged rains. If these occur the intervals between the applications may have to be shortened or in some cases an extra application given. For best results no unsprayed trees should be left nearer than about 200 yards from the sprayed trees. Cages should be placed over the ground under the worst infested trees in both orchards to compare the respective number of flies that emerge in each and thus act to some extent as a check. L. C.

Insects of Economic Importance, Outlines of Lectures in Economic Entomology, By GLENN W. HERRICK, pp. 1-138, 1915.

This volume, as indicated by its title, is the outline of lectures given by the author and presents in brief compass the salient facts regarding a large number of the more important insects, together with a discussion of control methods, insecticides and quarantine and insecticide laws. The arrangement is based upon the plant affected, the enemies of all the principal fruit, field and garden crops both north and south receiving due attention. There are also chapters on shade tree insects, the pests of the various domestic animals and those occurring in the house. There is no discussion of forest insects, presumably because this matter is taken care of in the College of Forestry. The treatment is practical, necessarily condensed and with each account of an insect there are given several well selected references to additional sources of information. Professional entomologists will find this a very convenient manual; for the practical farmer or fruit grower there are excellent diagnostic accounts of the injuries caused by the various pests together with directions for their control, while for the student we know of no better guide to the immediately practical side of applied or economic entomology.

Current Notes

Conducted by the Associate Editor

Mr. H. O. Marsh, entomological assistant, Bureau of Entomology, is temporarily stationed at Phoenix, Ariz.

Mr. C. Mason has recently taken up the post of Entomologist to the Department of Agriculture, Nyasaland.

Mr. A. Rutherford, entomologist, Royal Botanic Gardens, Ceylon, died February 3, from heart failure, following enteric fever.

Prof. G. M. Bentley, state entomologist of Tennessee, has been elected secretary-treasurer of the newly organized Tennessee State Florists' Society.

Mr. R. Veitch, late entomological assistant to the Imperial Bureau of Entomology, has taken up the post of entomologist to the Colonial Sugar Refining Company, Ltd., in Fiji.

Mr. Roy E. Campbell, scientific assistant, Bureau of Entomology, formerly stationed at Sacramento, Cal., will remove his headquarters there and establish a new station at Hayward, Alameda County, Cal.

Dr. Frank L. Thomas, a graduate of the Massachusetts Agricultural College, has taken up his new work as field assistant in entomology at the Alabama Agricultural Experiment Station at Auburn, Ala.

According to *Science*, Dr. Charles H. T. Townsend delivered an address on "Verruga and Its Transmission," at the tenth annual banquet of the Tompkins County Medical Society at Ithaca, N. Y., February 16.

Entomological Assistant W. D. Edmonston and Entomological Ranger George Hofer have joined Entomological Ranger Morris Chrisman, Bureau of Entomology, in the investigation of forest insect conditions in the mountains of southern Arizona.

According to *Science*, two French entomologists, M. Reymond Morgon and M. Andre Vuillet, have been killed in battle. The publication of the *Bulletin de Societé Entomologique de France* has been resumed.

All divisions of the Bureau of Entomology, which are located in Washington, are now housed under one roof, as the Bureau of Biological Survey has moved out of the building, which is now devoted entirely to entomology.

Mr. C. F. Stahl, scientific assistant, Bureau of Entomology, has closed his station at Jerome, Idaho, and is opening a new station at Spreckels, Monterey County, Cal., for the study of the curly-top leafhopper (*Eutettix tenella* Baker).

Mr. W. W. Yothers, Bureau of Entomology, has been in Washington for consultation on citrus work in Florida. Mr. Sasscer visited Florida, inspecting Government plant introduction stations and looked after details of the enforcement of plant quarantines.

The work of the Sleeping Sickness Commission of the Royal Society having now terminated, Mr. W. F. Fiske and Dr. G. D. H. Carpenter are continuing their investigations into the bionomics of *Glossina* in Uganda under the direction of the Imperial Bureau of Entomology.

Dr. W. A. Lamborn, late entomologist to the Department of Agriculture, Southern Nigeria, has been appointed travelling entomologist in East Africa, under the Imperial Bureau of Entomology, in place of Mr. S. A. Neave, and is engaged on *Glossina* work in Nyasaland.

Mr. R. S. Leiby, for two and one-half years assistant in insect morphology at Cornell University, is now assistant state entomologist of North Carolina, with headquarters at Raleigh, filling the position made vacant by the resignation of C. L. Metcalf, who is now at the Ohio State University.

During January, Mr. Charles H. Popenoe, entomological assistant, Bureau of Entomology, was engaged at Laredo, Texas, in what is recognized as the principal onion-growing region of the South, in coöperation with Mr. M. M. High, in testing a traction sprayer designed especially for onion fields.

Mr. Fred A. Johnston, entomological assistant, Bureau of Entomology, will close the station representing this branch of the Bureau at Riverhead, Long Island, N. Y., and will establish a new station at Hart, Oceana County, Mich. One of the most important economic projects will be the control of the pea aphis.

Surgeon-General William C. Gorgas was awarded the Louis Livingston Seaman medal for progress and achievement in the promotion of hygiene and the mitigation of occupational disease, at the annual exercises of the American Museum of Safety held in New York on February 10. Congress, before adjournment, promoted him to the rank of major-general in the medical department.

A general conference was held on December 18, at Washington, to consider the danger of the introduction of the pink bollworm in the United States. The consensus of opinion expressed was that the present situation demands a quarantine against all foreign lint, with a provision for the importation of such cotton only in states outside of the cotton belt. It was also proposed that such southern mills as require foreign cottons be allowed to obtain it from stocks which have been in storage in northern localities for at least a year's time.

The Entomological Society of America elected, at the Philadelphia meeting, officers as follows: President, Vernon L. Kellogg, Leland Standford Junior University; first vice-president, J. S. Hine, Ohio State University; second vice-president, J. M. Aldrich, United States Bureau of Entomology; secretary-treasurer, Alex. D. MacGillivray, University of Illinois; temporary secretary for summer meeting, E. C. Van Dyke, University of California; additional members of the Executive Committee, C. T. Brues, Harvard University; W. A. Riley, Cornell University; T. D. A. Cockerell, University of Colorado; J. A. G. Rehn, Philadelphia Academy of Natural Sciences; A. L. Melander, Washington Agricultural College.

The reports on experimentation and demonstration control work against the *Dendroctonus* beetles, carried on in the Yosemite National Park, Bureau of Entomology, in coöperation with the Department of the Interior, with Entomological Ranger J. J. Sullivan as instructor on practical details, and on private lands of the McCloud River Lumber Company, north of Mt. Shasta, in California, with Entomological Ranger J. D. Riggs as instructor, show the following results: In the Yosemite Valley and vicinity, at an elevation of from 4,000 to 7,500 feet, 302 Dendroctonus infested trees were treated, consisting of yellow, Jeffrey, and sugar pine. The trees ranged in di-

ameter, breast high, from 12 to 68 inches, with an average of 31 inches. The average cost of felling, barking, and the necessary burning, was $2.57 per tree. In the Toulumne River and Tenaya Creek, drainage of the Yosemite Park, at an elevation of from 8,000 to 9,500 feet, 2,018 infested lodgepole pine trees, ranging in diameter from 14 to 52 inches, averaging 23.7 inches, were treated at an average cost of $1.13 per tree for felling and burning the bark on the trunks sufficiently to kill the insect. Fifteen hundred and eighty-four infested trees were treated in this general area in 1913. The total number of trees treated in the Valley and Park, during 1913 and 1914, were 3,904, at a total cost for control work of $4,713.43, or an average of $1.21 per tree.

On the 17th and 18th of February the New Jersey Mosquito Extermination Association held its second annual meeting at Atlantic City, N. J. The program was opened by the president's address and a symposium on the special problems which have had to be met in the practical work of mosquito control. Among the points new to mosquito work it was shown that on shut-in, low-lying, sewage-charged salt marshes, the ordinary trenching was impotent to prevent mosquito breeding under unusual combinations of tide, rainfall and cloudy weather. It was brought out that these difficult conditions were to be met by dikes, tide gates and low-head centrifugal pumps.

During the evening session Dr. L. O. Howard described the work of the Bureau of Entomology on the mosquito problems of the lower Mississippi Valley. He gave figures to show the great extent to which malaria reduces the profits of agriculture through affecting the health of the laborers. He described the thorough and interesting fashion in which the study of malaria carriers is being pursued in that region. Dr. Jacob G. Lipman, director of the New Jersey Agricultural Experiment Station, discussed the value of mosquito work in relation to the agricultural and urban development of New Jersey. He showed how successful mosquito extermination could add two hundred million or more to taxable values.

The morning session was opened by an account of the mosquito work in Connecticut, given by Mr. B. H. Waldron. This paper was followed by an account of malaria in New Jersey, in the course of which Dr. A. Clark Hunt showed that the prevalence of malaria is much greater in certain local areas than is usually recognized. Dr. T. J. Headlee showed that, from the beginning of the mosquito extermination work to the year 1912, approximately $200,000 from all sources had been expended, $130,000 of which had been contributed by the state and $70,000 by municipalities and private individuals. He showed that property values within the protected zone had increased by more than five and one-half millions of dollars and that one and one-half millions of people were relieved to a very noticeable extent from mosquito troubles. He showed that, beginning in the year 1912, the county as a mosquito fighting unit had developed to such an extent by 1914 that it was expending approximately $130,000 a year and affording protection from all species of mosquitoes to one and one-fourth millions of people.

Beginning in the evening and extending through the following forenoon addresses were presented from the standpoint of the legislator, the freeholder and the tax-payer, in the course of which it was clearly brought out that the people paying the bills were satisfied with the progress of the work.

The following officers were elected: Dr. Ralph H. Hunt of East Orange, president; Dr. William E. Darnall of Atlantic City, vice-president; Dr. H. H. Brinkerhoff, of Jersey City, second vice-president, and Dr. Thomas J. Headlee of New Brunswick, secretary-treasurer.

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VOL. 8 JUNE, 1915 No. 3

Proceedings of the Twenty-seventh Annual Meeting of the American Association of Economic Entomologists

(Papers Read by Title, Continued)

FLIES WHICH CAUSE MYIASIS IN MAN AND ANIMALS—SOME ASPECTS OF THE PROBLEM

By F. C. BISHOPP, *Bureau of Entomology* [1]

SOME FORMS OF MYIASIS AND SPECIES OF FLIES CONCERNED

For many years medical literature has contained reports on cases of myiasis of different kinds in man. It is impossible to say how long man and animals have been subject to the attack of fly larvæ. It is safe to conclude that the meat breeding habits of certain Sarcophagidæ and Muscidæ have existed for many centuries, and although the habit of attacking living animals may have been developed later, there is in many cases no material difference between the infesting of dead and decaying tissue in a living animal and the infestation of carcasses. From this point it is but a short step to the development of the habit of feeding on healthy as well as dead and diseased tissue, and ultimately we find the forms which freely attack uninjured tissue requiring nothing but an external drop of blood to attract the fly and induce deposition. In the Œstridæ, or bot fly family, we find a more intimate and complete relationship to or dependency upon the host. The form of myiasis produced by this group of flies is quite different, of course, from that exhibited by the Sarcophagids and Muscids.[2] The flies are more specialized in habit and structure for parasitic life. This degree of

[1] Published by permission of the Chief of the Bureau of Entomology.

[2] Cordylobia, an African genus which has been considered to be a Calliphorine, has a habit somewhat similar to the bots. The larvæ of this group cause dermal myiasis in man and lower animals. In Africa we also find the Calliphorine flies of the genera Auchmeromyia and Chaeromyia, the larvæ of which have the peculiar habit of sucking blood from man and the lower animals.

specialization varies to some extent with the species. We see, for instance, an example of the most complete form of parasitism in the ox warbles of the genus Hypoderma; here the parasite has become highly dependent on the host, and confines attack largely to one host, the ox. The habit of the larvæ of migrating to the back of the host, where development is completed, and the fact that the larvæ seldom live if removed from the host a short time even before their normal emergence, probably indicates a closer relationship to the host than in the case of the horse bots or other members of the family. Although this is an exceedingly interesting group of flies it is not my purpose to dwell at length upon it, except to call attention to the occurrence of some of the varied forms of myiasis produced.

The sheep bot (*Œstris ovis*) is primarily a pest of sheep yet we find that it attacks other animals and even man. Ed. and Et. Sargent[1] state that this fly attacks man in certain elevated regions in the Sahara where sheep are less numerous than people. The eggs or larvæ are deposited upon the conjunctival and nasal mucous membranes of man and cause much trouble from March to June. In this country no records have been made of myiasis in man produced by this species. It is fairly common in many parts of the United States, and the habit of the larvæ of passing up the nostrils and into the sinuses of sheep is well known. It is not usual for it to invade the tissues of the host but appears to subsist on the mucous secretions.

The ox warble (*Hypoderma lineata*) is our most important species in the United States. Its near relative, *H. bovis*, has recently been found by Drs. Hadwen and Hewitt to have a wide range in Canada, and it is now probably within our northern border. Certain points in the biology of our species have not been definitely determined, and these are giving rise to considerable discussion. The entomologists in this country are inclined to the view that the larvæ gain access to the back of the bovine host by way of the œsophagus, while some European authorities believe the larvæ penetrate the skin along the back or migrate beneath the skin from the legs to the back. It is not my purpose to discuss the merits of the case. If it is true that the larvæ migrate from the œsophagus to the back, we have a case of a combined internal, transient myiasis followed by dermal myiasis. Cases of man being infested by larvæ of this genus are not rare. In some instances the larvæ move about beneath the skin until mature, while in other cases they have been recorded as developing at the root of the tongue or within the orb of the eye.

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[1] 1913. Sargent, Ed. and Et. La "Tamné," myiase humaine des montagnes saharennes tonareg, identique à la "Thimni" des Kabyles, due à *Œstris ovis*. Bull. Soc. Path. Exot., Paris, VI, pp. 487–488.

In this same family we have three or more species of horse bots with more or less different habits, but all attaching to the stomach or intestines of the host. These probably derive their food largely from the secretions of the mucous membranes and from the contents of the digestive tract. The exact relationship to the host is not known and it is important that the extent of injury to the host be carefully determined, as is being done in the case of Hypoderma by the German commission which has been studying that problem.

Among the Œstridæ we also find the species *Dermatobia hominis,* which is a common cause of dermal myiasis in man and a number of the lower animals in tropical America, and the members of the genera Cuterebra, Œdemagena, Gedœlstia and Cephenomyia. None of these latter forms have been known to attack man.

Comparatively little is known regarding the exact rôle flies play in myiasis of the intestinal and urinal tracts. Numerous records have been published showing from one to several species in the following families to be concerned: Therevidæ, Syrphidæ, Muscidæ, Anthomyidæ and Sepsidæ. In many instances rather serious disturbances in man are due to the larvæ of these flies. No doubt many infestations pass unnoticed or produce only minor symptoms, the larvæ depending on the food of the host for sustenance, and thus producing no direct injury. The mode of infestation and the effects of the larvæ on the host deserve much more attention than has been accorded them.

I desire at this time, to deal particularly with the various species of flies, the larvæ of which infest man or animals in wounds or, as not infrequently happens, attack inflamed or even entirely healthy parts. The species concerned are members of the families Muscidæ and Sarcophagidæ, as recognized by most of our American dipterists. In the United States the forms which are most important in causing this form of myiasis are *Chrysomyia macellaria, Lucilia sericata, L. cæsar, Phormia regina,* and one or two species of Sarcophaga. Possibly species of the genus Calliphora and Cynomyia are sometimes concerned. *C. macellaria* far outranks all others combined in importance. This species occurs in Mexico, the West Indies, Central America, and South America. In South America, Neiva and Gomes de Faria[1] have shown that *Sarcophaga pyophila* is responsible for some cases, at least, of human myiasis. These authors[2] also state that *S. lambens* is known to cause human myiasis in Brazil. In Hawaii, Van Dine

[1] 1913. Neiva, A. and Gomes de Faria. Notal sobre um caso de miiase humana ocasionada por larvas de *Sarcophaga pyophila* n. sp. Memorias do Oswaldo Cruz, Tomo V, Fasc. 1, pp. 16–22.

[2] *Ibid.* p. 18.

and Nörgaard[1] state that *Calliphora dux* Esch. during some seasons causes heavy losses among sheep by attacking scars caused by sheep scab and by blowing soiled wool, from which the larvæ ultimately work into the flesh. In Australia the losses to sheep raisers due to related species of flies have been enormous. Professor Froggatt has studied the various forms concerned and has published a number of papers dealing with the pests. The most important of these was published in 1913.[2] As a result of his investigations Professor Froggatt found that three species of blow flies indigenous to Australia are responsible for the infestation of sheep. These are *Calliphora oceaniæ*, *C. villosa*, *C. rufifacies*. Although the common green-bottle flies, *Lucilia sericata* and *L. cæsar*, occur commonly in Australia, these species have not been bred from soiled wool in that country. In Great Britian, and parts of continental Europe, these species, especially *L. sericata*, are commonly known as the sheep maggot flies, being responsible for the blowing of wool there. In southern Russia it appears that the fly, *Wohlfahrtia magnifica*, is the principal culprit in connection with this type of injury to sheep. Portchinsky[3] states that this species, which is viviparous, is very annoying and dangerous to sheep. Twenty-five per cent or more of the sheep are infested annually by its larvæ. *Sarcophaga ruficornis* is one of the flies which produces severe forms of myiasis in India.

Importance of Muscids and Sarcophagids which cause Myiasis in Man and Animals in the United States

Relationship to Slaughterhouse and Other Food Products.—As has been stated, a number of species of flies are concerned in the production of myiasis in man and animals. Of these, *Chrysomyia macellaria* is by far the most important. Aside from the causation of myiasis, the flies of this group are of considerable importance. They all have the habit of visiting carcasses and other decaying animal and vegetable matter, and are likewise rather strongly attracted to blood and fresh meat, as well as cooked meat and other good products. In parts of the south, in particular, these flies are a veritable pest about slaugh-

[1] 1908. Van Dine, D. L. and Nörgaard, V. A. Abstract of a preliminary report on insects affecting live stock in Hawaii. Proc. Hawaiian Live Stock Breeders' Association, Fifth Annual Meeting, 1907, pp. 19–70.

[2] 1913. Froggatt, W. W. and Cooper, W. F. The sheep maggot fly pest in Australia, pp. 88, figs. 15. The Cooper laboratory for economic research, Watford, England.

[3] 1913. Portchinsky, A. [Memoirs of the Bureau of Entomology of the Scientific Committee of the Central Board of Land Administration and Agriculture.] Vol. 9, No. 5, pp. 30, figs. 23. St. Petersburg.

terhouses. The small country plants which are not under the supervision of the government inspection service are especially prone to this condition. In most of these slaughterhouses the offal is left in the yard immediately adjoining the killing pens or is fed to hogs. Usually the hogs are not numerous enough to consume all of the offal, so that in either case a great number of these meat-infesting species are bred out. Under favorable seasonal conditions swarms of thousands of flies are present about the building, and as soon as an animal is skinned they begin feasting on the blood and the fresh carcass. If extreme vigilance is not exercised, the carcass is often blown in a short time after killing, and in some cases the eggs hatch and the larvæ begin to penetrate the meat. The meat-breeding flies are not the only species which visit food products in slaughterhouses. The house-fly is often present in great numbers and may contaminate meats with its feet and excrement, although it does not deposit eggs in such situations.

Knowing the filthy habits of the flies, we cannot help but look upon them as dangerous when allowed free access to food products. It has been shown by several investigators that various bacteria may pass through the alimentary tract of flies without destruction. Of course, where meat is well cooked probably these germs are all killed. On the other hand such food products as cooked meats, sausages, etc., which are usually consumed without further cooking, may be contaminated with all sorts of germs as well as fecal matter and other filth. Certainly, where flies have free access to carcasses, as is commonly permitted in many places, the bacteria of decay are introduced and the meat has its keeping qualities impaired. As has been pointed out recently in an Australian journal,[1] several advantages accrue from careful protection of meat from flies. In this instance the largest firm of butchers in Auckland began using screens for the protection of their meat. This resulted in a saving due to the prevention of trimming necessary when the meat is blown, improved the keeping quality of the meat, increased sales, and lessened the quantity of ice needed. In fact, they found the practice so advantageous they extended the screening system to all of their branches.

Although our butchershops in the towns and cities by no means furnish the best conditions as regards flies, they are incomparably better than the conditions often encountered at the small abattoirs. A careful inspection of such plants and the enforcement of sanitary regulations should be a part of the duty of every health officer.

Injury and Losses Due to Myiasis.—The flies of this group appear to be of little importance as causes of intestinal myiasis. A few cases

[1] 1913. The protection of meat from flies. Australian Medical Gazette, Sydney, Vol. XXXIII, No. 18, May 3.

have been observed where live stock have become infested with the screw worm (*C. macellaria*) in the stomach. These infestations were probably derived from licking wounds where eggs of the fly had been deposited, thus conveying the ova or young larvæ into the stomach where they penetrate the tissues. Considering the frequency with which animals lick infested wounds, it is remarkable that more evidence of internal attack is not at hand.

The habit of flies of attacking man is well known in the United States. Numerous cases have been reported by physicians and entomologists. Nearly all of these have been accredited to *C. macellaria*, although other species are no doubt responsible for part of them. In the southwestern states our investigations show that the infestation of man by fly larvæ is common. Cases of nasal or auricular myiasis have been well described in literature, so that further details are unnecessary. We have found, however, that the occurrence of larvæ in various parts of the body of man is not at all uncommon. The infested lesions on the surface of the body are much more easily freed from maggots than when these occur in the nasal or auricular regions, hence these cases have received little attention. Although infestations in cavities of the head formerly led to death or serious disfigurement, a better understanding of the pest has permitted physicians to treat such cases more successfully in recent years. Even now, however, death occasionally results from this cause.

Among live stock, myiasis is of most importance on the large ranches in west Texas, New Mexico, and Arizona. As has been stated, this loss is largely chargeable to the screw worm, *C. macellaria*. During early spring, however, there is considerable trouble among sheep on the ranches in west Texas, apparently due to the two species of Lucilia. This injury is of a different type from that caused by the screw worm. The soiled wool of ewes is infested at lambing time and, if not destroyed, the larvæ ultimately penetrate into the flesh and cause the death of the host. In treating cases it is often necessary to sheer a large portion of the sheep. The destruction of wool, together with the time occupied in treatment, to say nothing of the actual death of sheep, is a source of much loss among sheep-raisers.

During the winter months, especially when mild days occur following dehorning, castration and branding, infestation of resulting wounds by larvæ of *Phormia regina* is not uncommon. The infestation of heads of animals following dehorning is the most serious, and when not promptly treated frequently results in the death of the host. Possibly other species than *P. regina* are concerned in these winter infestations.

Our investigations indicate that nearly all of the cases of myiasis in animals during the summer and fall months are due to *C. macellaria*.

The damage chargeable to this species is of many classes. In certain sections of the southwest stockmen have found it unprofitable to keep breeding cattle on account of the heavy loss due to this pest at calving time. In these sections the stockmen depend mainly for replenishment of their herds upon purchase of yearlings. In nearly all of the cattle country of the southwest, the screw worm has had the effect of causing stockmen to reduce the size of their herds, especially during the fly season, in order that they may watch more closely the animals and promptly care for infestations. Under these conditions the actual death loss is not great although throughout the entire region the number of cattle actually killed by the screw worm must number well into the hundreds. Where animals become heavily infested with screw worms they have a tendency to penetrate thickets and are thus not found by the stockmen, and death usually results very shortly due to the extensive destruction of tissue by the larvæ or septicemia as a result of their presence.

Another important source of loss is the expense incurred by watching the herds and treating infested animals. Most of the pastures in the southwestern country are of great extent, many of them containing several thousand acres, and the promptness of treatment demanded necessitates the employment of a number of men to continually ride the pastures and treat the infested animals. The summer of 1913 was a year of especially great screw worm abundance and a large percentage of the stockmen found it necessary to employ extra help in order to prevent heavy death losses from infestations. During this season the percentage of infested animals in a herd ranged from ten to one hundred. In a number of instances from three to ten men were kept continuously busy on this line of work from May to November. To this we must add the expense of materials used in treating the infested animals. Chloroform is the most generally used, and I am informed by dealers that their sales of this material alone often reach five hundred dollars during one season. Individual owners of cattle sometimes spend several hundred dollars for chloroform, creosote products, pine tar, and other screw worm remedies.

Source of Infestation.—The screw worm, *C. macellaria*, has developed a very marked tendency to attack living animals although it breeds in great numbers in carcasses. This frequently gives rise to infestation of an animal on the least provocation. Years when the flies are very numerous, practically every scratch becomes a site for screw worm entrance. These may be made by brush, barbed wire, or the horns of other animals. On account of the frequency with which wounds are attacked the stockmen usually do not mark or brand live stock after May first or before November first. In this way they avoid much trouble.

Even when branding is done during late spring or early fall the maggots frequently infest the injured area. Dehorning and castration are almost invariably done during the winter months to avoid screw worm attack. Any animal giving birth to young during summer months is likely to become infested and the offspring is frequently attacked at the navel. Calves often get blown in their mouths, causing the loss of their teeth. Practically all animals are attacked but cattle are probably most susceptible. Infestation in hogs is usually seen in their ears as a result of wounds due to fighting. In the case of sheep, goats and dogs, infestation may occur on any portion of the body where injury is sustained. This species does not deposit on soiled wool but is strongly attracted to blood.

Another frequent source of infestation results from the presence of the cattle tick or other species, and live stock attacked by large numbers of horn flies, stable flies or Tabanids invariably develop cases of screw worms. Heavy infestations of ticks produce skin lesions, and when screw worm flies are numerous they frequently blow spots where a tick has been crushed, the larvæ penetrating through the skin. The large number of cases of screw worm infestations developing from the presence of ticks has caused an increased desire on the part of stockmen in many sections to eradicate the tick, and by this means lessen the injury by the screw worm.

Relationship of Meat Infesting Flies to Disease Transmission.—This question has been briefly touched upon under the discussion of slaughterhouse conditions. It is a question which has received little attention but is deserving of more extended investigation. It seems certain that there is some connection between the carcass-infesting flies and the so-called limberneck in chickens. Chickens have been observed to become partially paralyzed and frequently to die from the eating of maggots and decaying animal matter. We now have investigations under way to determine the relationship existing between the maggots and this disease. Dr. E. W. Saunders, of St. Louis, believes that there is some connection between limberneck in fowls and poliomyelitis in man, and that certain species of blow flies are responsible for the transmission of the disease. He has recently published[1] the results of some experiments along this line.

During the last two years rather severe outbreaks of anthrax have occurred among live stock in Texas. Observations on the habits of the meat-infesting flies, particularly *C. macellaria,* in connection with these outbreaks, certainly suggest the possibilty of the transmission of this disease by them. Carcasses of animals which have suc-

[1] 1913. Saunders, E. W. The prophylaxis of poliomyelitis, anterior acuta. Journal State Medical Association, IX, No. 12, pp. 385–389.

cumbed to the disease are soon covered with swarms of flies which feed upon the excreta, blood, etc., and then pass to wounds on other animals where infection may be produced by bacilli carried on the legs and body or by regurgitation of the germ-laden food or possibly by excrement. Thousands of flies develop in the carcasses where they are not properly disposed of and there is a strong probability of the resulting flies being capable of conveying the virulent organisms to healthy animals.

Summary of Life-History and Seasonal History of Some of the Species of Flies which Produce External Myiasis in the United States.

Mr. E. W. Laake, working under my general direction, at Dallas, Texas, is responsible for most of the notes on the life-histories from which the following summaries have been made. Work along similar lines was conducted by Mr. J. D. Mitchell at Victoria, Texas, and by Mr. D. C. Parman at Uvalde, Texas.

Chrysomyia macellaria.—The method of wintering of this species has not been definitely determined. In our hibernation experiments with adults and immature stages we have been unable to carry the species through the winter. This, and other points, indicates that the species normally dies out in the winter except possibly in the extreme southern portion of the United States, and in the tropics, and the reinfestation of the country progresses as the season advances. The species appears shortly after settled warm weather begins in the spring and the number usually increases until frosts in the fall. Often a partial checking of the ravages of the species occurs in midsummer, especially when the weather is hot and dry. The first infestations of live stock are found usually in May, and September and October are as a rule the months of greatest injury. In western Texas, where the rainfall is normally small, the years with abnormally heavy rainfall are generally the most productive of screw worm infestations.

The period from emergence of adult flies to deposition of eggs ranges, as observed by us, from three to eighteen days. As many as eight consecutive depositions by one fly have been observed to take place, the period between depositions being from one to seven days. Under the best conditions it seems that the depositions may occur at intervals of two to four days. The number of eggs deposited in one batch appears to vary from forty to two hundred forty-eight, and the greatest number recorded from one female was twelve hundred twenty-eight. The larvæ hatch within a few hours. Pupation occurs from six to

twenty days later and the pupal period ranges from three to twenty-seven days. The total developmental period from egg to adult has been found to vary from nine to thirty-nine days. None of these records were made on infestations in living animals. Breeding proceeds continuously throughout the summer, and no doubt from ten to fourteen broods are produced in one season in southern Texas. Considering the reproductive capacity of this species it is not surprising to note the millions of flies present about decaying animal matter in mid-summer. By rather careful estimation we judge that a single carcass may produce upwards of a million flies of this species.

We have observed a very marked tendency of this fly to breed in animals which have died recently rather than in old carcasses. This habit probably is related to that of the species depositing in living animals. Although some observers have found this species commonly deposits living young in the more northern latitudes, we have failed to observe this phenomenon in connection with our work. This species occurs normally in all sorts of situations in the Southwest, but we have observed a marked tendency for it to be found in great numbers far from any habitation. In such situations often no other species of meat-infesting flies is to be seen, while in cities the two species of Lucilia often outnumber the one under discussion.

Lucilia sericata.—Our experiments indicate that this species normally passes the winter in the larval and pupal stages. It is usually seen flying about or breeding early in the spring before *Chrysomyia macellaria* has appeared. Breeding takes place in decaying animal matter, although the adult flies are often seen frequenting all sorts of places in search of food. The first oviposition occurs, in summer time, within five to nine days after the adults emerge from the puparia. The incubation period varies greatly with the temperature. In summer, hatching takes place in less than twenty-four hours while in autumn we have a record of seven days. Pupæ are formed in three to nine days after hatching, and adults emerge within three to thirteen days after pupation. The developmental period, from egg to the emergence of the adult, ranges from nine to twenty-one days. These records were made during comparatively warm weather.

Lucilia cæsar.—This species, like the one just discussed, winters in the larval and pupal stages, the adults appearing on the first warm days of spring or even during warm periods in mid-winter. We have observed a preoviposition period in this species of six to twenty days. The eggs usually hatch in less than twenty-four hours, the larvæ begin migrating from the food two to five days later. Pupæ are formed three to twelve days after hatching. The pupal period ranges from five to sixteen days and the total developmental period from eleven to

twenty-four days. These records were also made when the temperatures were comparatively high. When low temperatures prevail often the prepupal stage may be greatly delayed, sometimes lasting for several weeks.

Phormia regina.—This is the common black blow fly which is seen entering houses, cellars, etc., during the cool days in late fall and early spring. It appears that this species is much better adapted to cool climates than those previously discussed. In fact, in the southern states this form practically disappears with the coming of hot weather, and is not seen again until the cooler days of autumn. At the latitude of Dallas, specimens of this fly have been observed frequently in mid-winter resting in sunny places. This species, like the others, is largely a carrion feeder and after the appearance of cool weather in the fall it largely supplants Chrysomyia and the Lucilias as a scavenger, continuing to breed throughout winter.

The adults begin depositing in seven to eighteen days after escaping from the puparia. The egg stage varies much with the temperature, ranging from less than twenty-four hours up to nearly four days, as recorded by us. The duration of the larval stage is from four to fifteen days, the pupal stage from three to thirteen days, and the total developmental period ten to twenty-five days.

Calliphora erythrocephala.—This species is not abundant in Texas, but is fairly numerous in the eastern part of the state. The flies of this species were observed by us to begin depositing eggs in twelve to seventeen days after emergence. The incubation period is twenty-four hours, and the larvæ begin to migrate from the food three or four days after hatching. The pupal stage lasts from seven to nine days. The time from deposition of eggs to the emergence of adults ranges from fifteen to twenty days.

Cynomyia cadaverina.—This is the large blue bottle fly which in association with *Phormia regina*, appears in Texas after the heat of summer has passed. It is notorious as a frequenter of pantries and cellars where it avails itself of every opportunity to deposit eggs on food products of an animal origin. It is not averse to depositing on smoked meat, although uncured meat, especially if cooked or becoming rancid, seems to be preferred. The first eggs are deposited from seven to twenty days after emergence of the adult; these hatch in one or two days and the larvæ, which are ravenous feeders, begin entering the soil three to five days later. Puparia are formed five to thirty-nine days after the larvæ hatch, and the duration of the pupal stage ranges from six to fifty-eight days, as shown by our tests. The time occupied for the complete development of the insect, from egg to adult, ranges from thirteen to ninety-nine days.

Summary of Control Measures Suggested

The fact that carrion breeding flies have been looked upon largely as beneficial insects on account of their habits as scavengers and the failure to associate in the minds of ordinary individuals, these scavenger flies and the flies which infest living animals and food, it is rather difficult to secure the adoption of remedial measures based upon the prevention of fly breeding in decaying animal matter. Nevertheless, this is the key to the whole system of control. The presence of screw worms in the southwest has come to be looked upon by stockmen as a necessary evil and year after year they continue to practice the treatment of infested animals without giving any attention to the sources from which the myriads of flies come.

The appearance of anthrax or charbon among herds in portions of Texas has, under the laws, compelled the destruction of animals dying from this disease. Many stockmen have, out of fear of the malady, proceeded to burn all dead animals, and this has had a salutory effect on the screw worm situation in some sections. Destruction by burning is the preferred method of disposing of carrion. In many cases, however, this work is not thoroughly done and the partially consumed carcass continues to breed out flies. An objection to this method of disposing of animal matter is that in some sections wood is very scarce, hence the burning is rather costly. Crude oil or kerosene may be largely substituted for wood in such cases. Other objections to the feasibility of the destruction of carcasses on the large ranches in west Texas are the difficulty of finding the dead animals until at least one brood of flies has been produced and the fact that carcasses of wild animals may also breed considerable numbers of flies, but these do not nearly offset the protection derived from the consistent destruction of animals which are promptly located after death. It appears that where Chrysomyia and other species are prevented from increasing to great numbers, the chances of living animals being attacked are almost negligible.

Second to the burning of carcasses comes burying. Our experiments indicate that it is necessary to cover a dead animal, which has become infested with maggots, to a depth of at least two feet in order to prevent the completion of development and the emergence of flies. If animals are buried before they become infested this depth may be greatly reduced, as a few inches of soil well packed over a carcass will prevent adult flies or their offsprings from reaching it.

In order to prevent infestation of man or animals, protection of wounds from the flies is essential. Man, especially when subject to chronic catarrh, should not sleep in the open without protection by a fly

net, hospitals should be carefully screened, and wounded animals may be placed in screened stalls or have the wounds treated with pine tar or other repellent substances. As has been said, infestation of wounds which are produced by branding, dehorning, etc., may be prevented by arranging to do this work during winter. If possible, even in winter it is well to choose a period when the weather is cool. The prevention of infestation of sheep at lambing time may be accomplished to some extent by lambing as early in the spring as feasible without danger of severe storms. Of course the careful surveillance of all live stock during the fly season is imperative.

The methods of treating infested animals, as now practiced by stockmen, seem to be fairly satisfactory. Of the larvæ destroyers, chloroform is best as it has great penetrating power. Pine tar is one of the best substances to place on the wound to prevent further infestation after the larvæ have been destroyed. Certain mixtures, many of which contain carbon bisulphid, are being put up and sold by druggists for the purpose of destroying the larvæ and at the same time preventing reinfestation. The fact that carbon bisulphid is somewhat attractive to the adult flies renders the use of this substance inadvisable.

The careful disposal of slaughterhouse offal by burning or deep burying, the screening of abattoirs, and the use of screens wherever animal food products are kept, will largely prevent the contamination of these articles by the various blow flies. In cities the complete disposal of garbage with incinerators is desirable.

The relationship to this group of flies of certain mammals and birds which act as scavengers is a subject of much interest and importance, but space will not permit of its discussion here. We have also found that climatic conditions may be important in controlling this class of flies. The sun often destroys a large percentage of the maggots developing on a carcass. Where dead animals are not burned or buried it is important to leave them in open places exposed to the sun rather than in the shade of thickets, as is commonly practiced.

KEROSENE TRAPS AS A MEANS OF CHECKING UP THE EFFECTIVENESS OF A POISONED BAIT SPRAY TO CONTROL THE MEDITERRANEAN FRUIT-FLY (CERATITIS CAPITATA WIED.) WITH A RECORD OF BENEFICIAL INSECTS CAPTURED IN THE KEROSENE.

By Henry H. P. Severin, Ph.D., and Harry C. Severin, M.A.

Italian, French and South African entomologists gave striking demonstrations of the effectiveness of the poisoned bait spray in the control of different species of Trypetidæ, and all obtained a great

reduction of infested fruit on those trees that were sprayed. Mally[4] in 1909, gave a decisive demonstration of the success of this remedy to combat the Mediterranean fruit-fly under South African conditions. "A severe outbreak of the pest in a commercial peach orchard was brought to a sudden and practically complete halt, and the fruit maturing later was marketed under the guarantee of freedom from maggots, . . . while that of untreated trees a few hundred yards away increased until practically every fruit was involved."

In a series of experiments on the use of petroleum, vegetable and animal oils to trap the Mediterranean fruit-flies, we found that ordinary kerosene (about 120° Bé.) captured more fruit-flies than any of the other oils, with the possible exception of distillate (about 48° Bé). As distillate is too volatile for practical purposes it was decided to use traps containing kerosene as a means of checking up the effectiveness of a poisoned bait spray employed in the control of the Mediterranean fruit-fly.

When the Mediterranean fruit-flies issue from the pupæ, the eggs are undeveloped and the adults require from ten to twelve days before the egg-laying period begins. This period may be termed a *feeding period* and during this time the flies subsist on the waxy coating of fruit, juices of injured fruit on the trees or infested, fallen fruit on the ground. Our attention was also called to the fact that the Mediterranean fruit-fly feeds upon flowers of a chrysanthemum imported from Japan, but the pest was not attracted to these flowers in any great abundance. After a rain the fruit-flies were frequently seen lapping up droplets of water on the leaves. In captivity the flies show a fondness for diluted molasses and they would feed on this liquid until their abdomens became greatly distended. The greediness of the adults for sweets is the weak point in the life history of the pest and explains why the sweetened, poisoned sprays are so effective in the control of this insect. After the eggs are fully developed in the ovaries, the insect is seized by a reproductive stimulus and then not only seeks a suitable medium in which to deposit its eggs but also continues to search for food. This period, which may be called a *reproductive* and *feeding period*, commences at the time the eggs are fully developed and continues until the last egg is deposited.

In our work the poisoned bait was prepared according to the following formula, which is slightly modified from that recommended by Mally:

Brown sugar	$2\frac{1}{2}$ lb.
Arsenate of lead	5 oz.
Water	4 gal.

The solution was prepared by dissolving the brown sugar through a cheese-cloth bag in cold water so as to strain out all foreign material including ants, which in the Hawaiian Islands frequently gnaw through the paper sacks containing the sugar. The mixture was thoroughly agitated by pumping the liquid back upon itself with a common, garden, brass spray-pump. This pump was provided with a rose sprinkler nozzle which throws a mist-like spray (Pl. 13).

To determine the effectiveness of the poisoned bait spray as a means of controlling the Mediterranean fruit-fly under Hawaiian conditions the following plan of procedure was adopted. For a period of five weeks, ten kerosene traps were wired to the branches of citrus trees of an orchard containing about four hundred orange, lemon, grape-fruit, banana, fig, guava, papaia, peach, pear, pepper, plum and mango trees. No spray was applied to any of the trees and vegetation in the orchard during this period and exact data were kept concerning the number of fruit-flies and beneficial insects found dead in the oil traps. During the following five weeks, the poisoned bait was sprayed once a week upon all of the fruit-bearing trees and again a record was kept of all the Mediterranean fruit-flies and beneficial insects captured in the traps. A comparison of the number of fruit-flies caught in the kerosene traps before, during and after spraying would test the value of the fruit-fly remedy.

The following table shows the number of male and female fruit-flies which were captured in the oil traps at intervals of from two to four days for a period of five weeks before spraying:

TABLE I

Number of Male and Female Mediterranean Fruit-Flies Captured in Ten Kerosene Traps at Intervals of Two to Four Days for a Period of Five Weeks Before Spraying

	♂	♀
Oct. 8– 9, two days' catch	683	2
Oct. 10–11, two days' catch	631	0
Oct. 12–13, two days' catch	454	0
Oct. 14–16, three days' catch	734	3
Oct. 17–20, four days' catch	1,090	1
Oct. 21–24, four days' catch	1,150	0
Oct. 25–28, four days' catch	1,622	6
Oct. 29–Nov. 1, four days' catch	986	3
Nov. 2–4, three days' catch	951	2
Nov. 5–7, three days' catch	491	7
Nov. 8–11, four days' catch	1,411	12
Thirty-five days' catch	10,203	36
	36	
	10,239 Total	

Average: 291 males captured per day.
1 female captured per day.
292 Total.

From this table it is readily seen that kerosene used in traps as a control for the Mediterranean fruit-fly is entirely out of the question, for the number of fruit-flies captured during the last four days is not smaller than the number caught during the first four days. Furthermore, of the 10,239 flies captured, only 36 were females, the remainder being males. And again, at the end of the fifth week almost every ripe orange was "stung" by the pest.

During the next five weeks the fruit-fly spray was applied to all of the fruit-bearing trees, about once a week, under the most unfavorable weather conditions. The applications of the spray were made during the rainy season and since this orchard is situated on the outskirts of Honolulu in Manoa Valley where rains are more frequent than in the city itself, the effectiveness of the poisoned bait was to receive a most thorough test. The rains were so frequent in this valley that the spray rarely remained on the leaves of the trees more than a day or two at the most and in one instance only a few hours before a rain fell. Hundreds of fruit-flies were present in this orchard before the application of the first spray and at this time it was an easy matter to capture several hundred specimens in an hour by sweeping with an insect net among the orange trees. This orchard was not isolated but was adjacent to a very much neglected orchard which was also teeming with the pest. Horticultural sanitation was not rigidly practiced throughout this entire experiment. All fallen, infested, citrus fruits, however, were collected daily and thrown into a barrel containing water, but since the larvæ of the pest are able to live for several days in fruit submerged in water, the fruit was removed from the barrel from time to time and burned. The wind breaks of this orchard consisted of high guava trees but very little of the fallen fruit from these trees was destroyed although the same was infested. Papaias, plums and tomatoes were allowed to decay on the ground. The following table shows the number of fruit-flies which were captured in the traps during and after spraying:

TABLE II

Number of Male and Female Mediterranean Fruit-Flies Captured in Ten Kerosene Traps at Intervals of Two to Five Days for a Period of Five Weeks During and After Spraying

	♂	♀
After first spraying, Nov. 12–14, three days' catch	51	2
After first spraying, Nov. 15–17, three days' catch	40	0
Six days' catch	91	2
After second spraying, Nov. 18–21, four days' catch	12	1
After second spraying, Nov. 22–23, two days' catch	0	1
After second spraying, Nov. 24–26, three days' catch	8	0
Nine days' catch	20	2

Applying the poisoned bait, in the form of a mist-like spray, with a common garden, brass spray-pump provided with a rose sprinkler nozzle

After third spraying Nov. 27–30, four days' catch	2	2
After third spraying Dec. 1– 3, three days' catch	0	0
Seven days' catch	2	2
After fourth spraying, Dec. 4–5, two days' catch	1	0
After fourth spraying, Dec. 6–10, five days' catch	25	1
Seven days' catch	26	1
After fifth spraying, Dec. 11–13, three days' catch	23	0
After fifth spraying, Dec. 14–16, three days' catch	12	1
Six days' catch	35	1
Thirty-five days' catch	174	8
	8	
	182 Total	

Average { 5 males captured per day.
1 female captured in about every 4 days.

A comparison of Tables I and II shows that there were 10,239 fruit-flies captured before spraying and only 182 during and after spraying, a reduction, therefore, of 10,057 specimens. Of the 182 Mediterranean fruit-flies captured during and after spraying, 93 were caught during the first six days, and 89 during the following twenty-nine days. After the application of five sprays, it usually required a thorough search to find an infested orange in the orchard, whereas before spraying, almost every ripe orange had been "stung" by the pest. See plate 14.

For a period of five weeks after December 16, no spray was applied to any of the trees in the orchard where the previous work was done but the ten kerosene traps were still kept wired to the same citrus trees. The following table shows the number of fruit-flies taken in these traps during this time:

TABLE III

INCREASE IN THE NUMBER OF MEDITERRANEAN FRUIT-FLIES CAPTURED IN TEN KEROSENE TRAPS FOR A PERIOD OF FIVE WEEKS AFTER SPRAYING WAS DISCONTINUED

	♂	♀
Dec. 17–20, four days' catch	23	0
Dec. 21–24, four days' catch	46	0
Dec. 25–27, three days' catch	37	0
Dec. 28–31, four days' catch	85	0
Jan. 1– 4, four days' catch	81	0
Jan. 5– 8, four days' catch	70	0
Jan. 9–12, four days' catch	92	1
Jan. 13–17, four days' catch	97	0
Jan. 18–21, four days' catch	134	0
Thirty-five days' catch	665	1
	1	
	666 Total	

Average { 19 males captured per day.
1 female captured in 30 days.

A comparison of Tables II and III shows that the Mediterranean fruit-flies had again increased in numbers during the five weeks in which no spray was applied to the fruit trees. An examination of the fruit trees of this orchard after these five weeks had elapsed showed that some of the fruit had again been "stung." Trapping the pest with kerosene was continued in this orchard in connection with other experiments, and fifteen weeks after spraying was discontinued, 642 fruit-flies were captured in three days in the ten traps, or an average of 214 per day.

The gradual increase in the number of Mediterranean fruit-flies in this orchard after spraying was discontinued may be attributed to a number of causes: (1) horticultural sanitation was not rigidly practiced and many trypetids emerged from the fallen, infested fruit; (2) this orchard was not isolated but was adjacent to a very much neglected orchard from which probably many flies migrated; and (3) fruit-flies breeding in the wild fruits, covering thousands and thousands of acres in the mountainous districts, were probably caught up by the winds and carried into this orchard. We [5] have published the results of an experiment on the flight of two thousand marked, male, Mediterranean fruit-flies and have demonstrated that marked specimens, set free from the side of a mountain at an elevation of 350 feet, were carried by the prevailing winds. Some of these marked insects were captured in kerosene traps in this orchard, a mile from the point of liberation.

After taking Weinland, California's representative stationed in Honolulu, into an orchard and showing him our methods of checking up the effectiveness of the poisoned bait spray by means of kerosene traps and the results obtained. this entomologist carried on a similar experiment in a residential section of Honolulu. Weinland [6] sprayed only the low host trees, for with the apparatus at hand "it was impossible to spray higher than ten feet." He plotted a curve in checking up the efficiency of the spray with the use of kerosene traps and writes, "From the shape of the curve, it is apparent that there is a marked but temporary reduction in the number of flies caught. The lowest point comes about five days after spraying, after which time the spray becomes ineffective and flies coming in from outside sources raise the number again."

In our work, Mally's [4] formula of the poisoned bait spray was adopted but with this difference, Mally used three ounces of lead arsenate and we increased the amount from three to five ounces after the application of the first spray. The amount of poison was increased in our work in order to kill the flies more rapidly by giving them a greater dose of poison. To determine the length of time that fruit-

flies will live in captivity with leaves picked from trees sprayed with the bait containing three ounces of poison, thirteen fruit-flies were captured, some of which were actually observed feeding on the bait in the field. These flies were placed in jars together with the sprayed leaves suspended by threads at different heights. From time to time water was sprayed on the sides of the jars. The results of the experiment were as follows: Nine fruit-flies succumbed to the effects of the poison at the end of the first day, one by the end of the second, but the remaining three flies were still alive at the end of the third day.

When the fruit-fly spray has been properly applied to the trees, there is no conspicuous show of the bait from a distance, but a closer examination of the treated trees shows thousands and thousands of droplets of the spray adhering to the leaves and branches. These droplets, even after the water has evaporated, will not show the white traces of lead arsenate to the naked eye. If the solution has not been kept thoroughly agitated, the lead arsenate will sink to the bottom of the receptacle containing the mixture and the last few pump-fulls of the spray will contain an excess of lead arsenate. When this material is applied to the foliage, the lead arsenate in each droplet will settle as a white deposit, but this will be covered by a glossy layer of sugar after the water has evaporated (Pl. 14, fig. 2.) A rain may now wash off the sugar layer from the lead arsenate deposit and then, of course, the white specks become more conspicuous. These may adhere to the leaves for several weeks. In order to keep the finely divided particles of lead arsenate in suspension in the solution, every second pump-full of the spray was forcibly emptied against the bottom of the container.

After the trees in the orchard had been sprayed for the fifth time our attention was called to the fact that the leaves of the grapefruit and peach had been injured by the spray. The leaves showed evidence of brown areas as if they had been burned; later the leaves began to fall from the trees and in the case of the peach almost entire defoliation occurred. In the first two sprays, lead arsenate in paste form was used, but with the last three sprays the powdered lead arsenate was used. No attempt was made to determine the cause of the scorching of the leaves under Hawaiian conditions.

Shortly after the trees had been sprayed, a loud buzzing became audible as one walked through the orchard. Hundreds of insects, including house flies, bluebottle flies, syrphids, flesh flies, tachinids, mud daubers and paper wasps, hymenopterous parasites, long-horned grasshoppers, moths, an occasional butterfly, etc., were flying about sucking up the poisoned bait.

In several bulletins [1, 3] Mally claims that in South Africa "honey bees have paid no attention to the thin film of sweets on the leaves of

treated trees." In the Hawaiian Islands, however, we found that the spray does have a drawback from which Mally claims it was exempt—it does attract the honey bees. In one experiment fruit trees were sprayed which were not flowering but which were in the immediate vicinity of others that were in blossom. Honey bees were visiting these flowers in large numbers. Several hours later honey bees were observed feeding on the poisoned bait which was on the leaves of the treated trees, and also on the leaves of some shrubs and grass beneath the trees.

Mally [1] also claims that "citrus trees in blossom were sprayed . . . to determine the likelihood of destroying honey bees but in no case was a bee seen to feed on the poisoned sweet. It is possible that the blossoms were so much more attractive that the bait was no temptation." In the Hawaiian Islands, some of the honey bees will desert the best honey-producing flowers and seek the poisoned bait. At different times during the year when the algeroba, avocado, various kinds of citrus trees, papaia and peach trees were in blossom, these trees were sprayed with the fruit-fly remedy. Many honey bees, which had been observed visiting the flowers before spraying, left the flowers after spraying and were seen lapping up the deadly solution.

A record was kept of all beneficial insects, such as ladybird-beetles, staphylinids or rove-beetles, stylopids or strepsipterons, lacewings, tachinids and hymenopterous parasites which were captured in the kerosene. The following table shows a list of insects that were caught before, during and after spraying:

TABLE IV

List of Beneficial Insects Captured in Ten Kerosene Traps Before, During and After Spraying

PREDACEOUS INSECTS

Before spraying		During and after spraying
	Coccinellidæ	
2	Coccinella repanda Thunb	7
9	Cryptolæmus montrouzieri Muls	16
20	Orcus chalybeus Boisd	13
3	Platyomus lividigaster Muls	2
4	Rhizobius ventralis Muls	14
1	Vedalia cardinalis Muls	0
1	Scymnus vividus Sharp	0
1	Sticholotus punctatus Crotch	2
41		54
4	Coccinellid larvæ	4
7	Staphylinids	3
1	Lacewing larva	0
53		61

Average about 2 per day.

PARASITES

Stylopidæ or Strepsiptera

1	Elenchus melanias Perkins	0

Tachinidæ

3	Frontina archippivora Will	2
2	Chætogædia monticola Bigot	1
5		3

Hymenoptera

571	Tetrastichus hagenowii (Ratzeb.) (Secondary parasite)	57
6	Anastatus kœbelei Ashm	17
7	Solindenia picticornis Cam	1
2	Chalcis obscurata Walk	0
1	Pimpla hawaiiensis Cam	3
3	Ischiogonus palliatus (Cam.)	0
0	Encyrtus fuscus How	3
0	Cremastus hymeniæ Vier	1
590		82

19	Primary parasites	25
571	Secondary parasites	57

A large number of hymenopterous parasites which have not been identified were captured in the kerosene. Many parasites of which the hosts are unknown were trapped. Parasites new to the Hawaiian Islands, and of recent, accidental introduction, were caught in kerosene and other oils.

Besides the Mediterranean fruit-flies, predaceous and parasitic insects listed, a number of animals other than insects were caught in the kerosene; viz., one lizard, centipeds and many spiders. Of the insects captured, the largest number were (1) Mediterranean fruit-flies, (2) ants, (3) winged plant lice, (4) gnats or midges (in one catch 84 gnats or midges were counted), (5) bark lice and (6) moths. Among the Orthoptera, cockroaches, katydids, long-horned grasshoppers and one African mole cricket were taken in the oil. Among the Diptera, syrphid flies, soldier flies, vinegar flies, flesh flies and a few mosquitoes were killed in the kerosene. A few other insects that were found dead in the kerosene and worth mentioning on account of their economic importance are, the Japanese beetle (*Adoretus umbrosus*), Lantana leaf-bug (*Teleonomia lantanæ*), and Torpedo bug (*Siphanta acuta*).

It may be possible that some insects which have been captured with oil lamps are not attracted to the light but to the oil. According to Dr. Perkins, "It is just possible that Stylopidæ are attracted by kerosene, since one or two species have been taken in the oil on lamps, and are supposed to have been attracted by the *light*, but it may have been the *oil*."

We are indebted to Dr. R. C. L. Perkins of the Hawaii Sugar Planters' Association Experiment Station for the identification of the predaceous and parasitic insects.

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[4] MALLY, C. W., 1909. The Mally Fruit-Fly Remedy. *Ibid*, No. 49, pp. 1–6.

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EXPLANATION OF PLATE 14

Fig. 1. The two bottles on the right contain 10,239 Mediterranean fruit flies; these were captured in ten kerosene traps during five weeks before spraying. The bottle on the left contains 182 fruit flies and these were captured in ten kerosene traps wired to the same trees during and after spraying in the following five weeks.

Fig. 2. Leaf showing small droplets of spray. In this instance the solution was not kept thoroughly agitated and consequently the last few pump-fulls of the poisoned bait contained a large amount of the lead arsenate. The droplets of spray show a white deposit of lead arsenate covered with a glossy sugar layer; the latter is represented in black in the photograph.

[Last of the papers read by title.—Ed.]

A CONTRIBUTION TO THE LIFE HISTORY OF THE CORN-FEEDING SYRPHUS FLY (MESOGRAMMA POLITA SAY)

By C. H. RICHARDSON, *New Jersey Agricultural Experiment Station*

During the summer of 1913, the writer observed an infestation of *Mesogramma polita* which extended over a considerable portion of two hundred acres of sweet corn at Jobstown, Burlington County, N. J. The prosecution of other field work made it impossible to study the activities of this Syrphid in detail at that time. However, observations were made at frequent intervals and the results are given here as an addition to our present knowledge and a stimulus to further interest in this species.

References to the habits of *Mesogramma polita* are few. Riley and Howard,[1] who have given the most complete account of its life history,

[1] Insect Life, Vol. 1, 1888, pp. 5–8.

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report it from Griggstown, Somerset County, N. J., and Jacksonville, Fla. In the former locality, the larvæ were feeding on pollen from corn; in the latter they were attacking the corn tissue at the base of the leafstalk and were even found in soft discolored places in the stalk. Mr. Ashmead, who made the field observations at Jacksonville, states that he did not observe any of the larvæ feed upon pollen in that locality. In 1889 the same authors[1] published a letter from a correspondent at Cadet, Mo., in which damage to corn by the larvæ of *M. polita* was reported. In this locality, the informant found the larvæ between the bases of the leaves and the stems where they caused the lower leaves to wither and dry up.

The late Dr. John B. Smith cites an infestation in evergreen sweet corn at Cologne, Atlantic County, N. J.[2] The larvæ were found between the leaves and the stalks of the corn. Specimens kept in the laboratory lived apparently upon the moist exudation from the surface of the stalk where it envelops the leaf sheath. No pollen was given them, but they reached maturity successfully.

Sanderson in 1900[3] discovered this species in corn at Newark, Del. The larvæ were often found in the staminate flowers, in the axils of the leaves, in the silk and wherever else pollen had lodged. Puparia were observed among the florets on the tassels. Although the larvæ were very abundant, no injury to the leaves or stalks could be detected.

Folsom[4] has given the only account which the writer has seen of the aphidophagus habits of the corn-feeding Syrphus fly. He says, "*Mesogramma politum* is frequent in our clover fields, the green larva feeding on the clover-louse. A full-grown larva found on the ground March 27 made its puparium the same day, and the fly issued indoors April 8."

Metcalf[5] has considered a large part of the literature which relates to this species and has given observations made at Raleigh, N. C. In this locality he mentions that the pupæ were fastened to the tassels of the corn (p. 30).

Seasonal Distribution.—This Syrphid was first observed at Jobstown in a field of metropolitan sweet corn the last week in August when adults and larvæ were abundant, which would indicate that the breeding season was well advanced at that time. During September, the infestation spread to practically all of the fields. On October 11, the

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[1] *Loc. cit.*, Vol. 2, p. 115.

[2] Rept. Ent. Dept. N. J. Agr. College Exp. Sta., 1899, pp. 442–443.

[3] Rept. of Entomologist, Delaware Exp. Sta., pp. 202–205.

[4] Univ. of Ill. Agr. Exp. Sta., Bull. 134, p. 148.

[5] Syrphidæ of Ohio, Ohio State Univ. Bull., Vol. 17, No. 31, 1913, pp. 16–88.

number of flies had decreased perceptibly. Those seen were mostly males and the few females observed were not ovipositing. Pupæ were still present. After this date field work was discontinued.

Feeding Habits of the Adults.—Adults of both sexes seemed to feed exclusively upon pollen from the corn. Feeding was done in a more or less systematic manner. The flies would often hold an anther with their fore legs and, beginning at one end, would consume the pollen along its whole length.

The females were easily approached while they hovered about the tassels and it was not difficult to catch them with forceps when at rest. The males, however, exhibited a greater "shyness," and could rarely be obtained in this manner.

Oviposition.—Most of the eggs were deposited in groups in the staminate flowers, although a few, reposing singly, could be found on the leaves and other parts of the plants. The groups, which were always found on the inner surface of the glumes, contained as few as two or as many as nineteen eggs. The actual number laid by a single female was not ascertained.

The female, when ready to oviposit, alights on a stem, moves along until a suitable flower is reached whereupon she reverses her position and feels the way with her ovipositor to the inner surface of the glumes.

Feeding Habits of the Larvæ.—Young larvæ were found in the staminate flowers, but seemed to leave them after a short time and to collect in greatest abundance in the axils of the leaves. Many were also seen in depressions along the midrib of the lower leaves where pollen had accumulated. That they fed largely on pollen was corroborated by actual observation and by examinations of the digestive tract. Larvæ were often seen in the silk, but never as abundantly as in the axils of the leaves. Just prior to pupation, the larvæ usually abandoned the axils of the leaves and wandered about over the plant.

No deleterious effects of the larvæ upon the corn were noticed at Jobstown and in this respect these observations are in harmony with previous studies in New Jersey and Delaware. Whether or not the larvæ in the axils of the leaves fed upon plant exudations was not ascertained, but it was certain, if such feeding occurred, it did not appreciably injure the corn. Nor was there evidence to show that enough pollen was consumed to reduce the yield in the experimental plots where other studies were under way.

Pupation.—On September 12, a count was made to determine the preferred place for pupation with the following result:

Along midrib, upper surface of leaf	31	pupæ.
Along midrib, lower surface of leaf	4	"
On blade of leaf, upper surface	13	"
On blade of leaf, lower surface	1	"
At tip of corn ear	5	"

Other pupæ were found at later dates in the axils of the leaves, and in the sheath surrounding the ear, but they were invariably more numerous on the upper surface of the leaf. Sanderson and Metcalf have observed many pupæ on the tassels, but this was certainly not the preferred place for pupation at Jobstown.

Natural Enemies.—The most important enemy of the corn-feeding Syrphus fly was a disease which appeared to be particularly fatal to mature larvæ. Dead individuals were to be seen on nearly every corn leaf and on the stalks in places where the larvæ were particularly numerous. Sanderson mentions an apparently similar epidemic in Delaware.

While a larva of *Megilla fuscilabris* was found but once in the act of devouring a pupa of *M. polita*, there can be no doubt that it was an active enemy of the corn-feeding Syrphus fly because of its abundance in the corn fields and the large number of pupal remnants which showed the visitation of a predaceous insect.

Although a large number of pupæ were reared and many dissected, no internal parasites were found. In a few cases, eggs placed on leaves showed holes through which egg parasites had escaped.

Discussion.—*Mesogramma polita* has apparently never been injurious to corn in New Jersey or Delaware. Reports of injury have come, however, from Florida and Missouri and it seems that the feeding habits of this species will require closer attention in many localities before its exact economic status can be determined.

The observations of Folsom are particularly important because they indicate a hitherto unknown feeding habit for this species. If *M. polita* proves to be commonly predaceous then Metcalf's acceptance of it as a purely phytophagous species cannot be upheld. The close relationship of the genus *Mesogramma* with the aphidophagous genera, *Syrphus* and *Sphærophoria* as indicated by Riley and Howard [1] and the general resemblance of the larva to other predaceous Syrphid larvæ suggest its derivation from predaceous ancestors. This conception is further strengthened by the fact that *Mesogramma marginata* Say [2] is also predaceous in habit.

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[1] *Loc. cit.*, 1888.

[2] Folsom, *loc. cit.*

The present data suggest that the species is sporadic in its attacks upon corn. There are but three recorded outbreaks in the state of New Jersey for the period from 1885 to 1914, although New Jersey was one of the first states in which its presence on corn was noted. It may be that the corn-feeding habit is only occasional and that the larvæ normally lead a predaceous existence well hidden among close-growing vegetation.

LIFE HISTORY, NATURAL ENEMIES AND THE POISONED BAIT SPRAY AS A METHOD OF CONTROL OF THE IMPORTED ONION FLY (PHORBIA CEPETORUM MEADE) WITH NOTES ON OTHER ONION PESTS [1]

By Henry H. P. Severin, Ph.D., *Wisconsin Agricultural Experiment Station,* and Harry C. Severin, M.A., *South Dakota State College of Agriculture and Mechanic Arts*

I Introduction

As onion growers in some parts of Wisconsin have been forced to give up the business of growing onions on account of the ravages of the imported onion fly (*Phorbia cepetorum* Meade), an investigation was started to determine the life history, natural enemies, probable causes of the enormous increase of the pest and the value of the poisoned bait spray as a method of control. In this paper a few observations on other onion pests will also be noted. A more detailed paper on the imported onion fly and other insects injurious to onions will appear in the Wisconsin Academy of Sciences, Arts and Letters.

II Life History

In the process of oviposition the imported onion fly usually endeavors to force its ovipositor between the onion stem and the ground, but when the earth is tightly crusted against the plant, the egg-laying organ is unable to penetrate the hardened soil. The female fly may then oviposit in a crevice near the onion stem, or if a small crack is not available, the pest will sometimes crawl in holes or under lumps of dirt an inch or two from the onion plant to deposit its eggs.

The eggs are usually deposited from one-eighth to one-fourth of an inch below the substratum, and are glued to either the soil or stem. Sometimes the eggs may be found above the surface of the ground attached to the stem, within the axil of a leaf or to the leaves themselves. The number of eggs which are laid at one deposition may vary from one to fifteen.

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[1] Permission has been granted by Director H. L. Russell of the Wisconsin Agricultural Experiment Station for the advanced publication of this paper.

Under field conditions the incubation period of eggs deposited by the first brood of flies in early June varied from three to four days. The larval period was completed in two to three weeks in green onions, onion-sets and small seeded onions, but in seeded onions from the previous year, the development of the maggots was often prolonged and, in some instances, required from four to five weeks. The pupal period under field conditions required from nine to sixteen days during the latter part of June and early July, the majority of the second brood of flies emerging in eleven, twelve and thirteen days.

Several experiments were performed to determine whether the imported onion fly could complete its life history in food material other than the onion. In one instance, fourteen eggs immediately after deposition in an onion field, were placed below the surface of the soil in contact with radishes growing in a flower pot. Fourteen onion flies completed the different stages of their life cycle in twenty-nine to thirty-five days in the radishes. In a second experiment freshly laid eggs were transferred from onions to manure. The next day the eggs were shriveled in appearance and an examination of the manure disclosed the presence of numerous mites, that had undoubtedly sucked the eggs dry. The experiment was repeated but this time fresh horse droppings were used. The different stages of the life history in the manure were completed in twenty-nine to thirty-one days, except one fly which required fifty-two days to pass through the egg, larval and pupal periods.

An attempt was made to determine the number of days required after emergence of adults from puparia before fully developed eggs appeared in the ovaries. A large number of adults of the second brood, which emerged on the same day, were confined in breeding jars containing onions planted in wet sand. The specimens were fed daily on diluted molasses, and water was sprayed into the jars with an atomizer. Daily dissections of specimens confined in breeding jars showed that one of ten females had ripe eggs in the ovaries at the end of twelve days, but other females did not show mature eggs in the ovaries at the end of sixteen days. In all probability, the effect of confining the insects in breeding jars as well as the food material employed, played an important rôle in the rate of development of the eggs.

Through dissections of female flies of the first and second broods, it was found that the average number of apparently full-grown eggs present in the ovaries varied from forty-one to fifty-one. In all probability, the onion fly empties its ovaries of a batch of about fifty eggs, depositing from one to fifteen eggs at a time, a second batch of eggs probably then develops, ripens, and is deposited and so on.

The period of emergence of the second brood of onion flies under field conditions extended from June 28 to July 25, most of the flies

issuing from July 1–12. We determined by a series of daily dissections of twenty flies which were captured by sweeping the onions with an insect-net, when the second brood is about to oviposit in the onion fields. On July 10, 55 per cent of the females dissected contained almost fully-developed eggs in the ovaries. Two of the twenty specimens dissected on this date had already deposited eggs, for only two ripe eggs were found in the ovaries of one female and three were present in the other.

III Natural Enemies

The most important natural enemy of the onion maggot in Wisconsin is a Staphylinid or rove beetle (*Aleochara anthomyiæ* Sprague). On July 1, three hundred imported onion fly puparia were sieved from the soil in a green onion bed. From July 16–30, twenty-seven (9 per cent) Staphylinids emerged, whereas the last onion fly issued on July 13, from these puparia. When an onion maggot is dropped into the breeding jar near the Staphylinids, the larva is seized by the mandibles of the beetles and the Coleoptera tenaciously cling to the wriggling maggot as the victim is being devoured. In the field masses of onion fly eggs were found which had been partly devoured by some predaceous enemy, and it may be possible that the Staphylinids preyed upon these eggs.

Two wasps (*Oxybelus 4-notatus* Say), each dragging an onion fly, were captured in an onion field on July 21. In all probability, this wasp sometimes provisions its nest with this pest.

Spiders were frequently observed sucking out the juices of the imported onion flies. These spiders were commonly seen lying in wait for their prey at the union of two onion leaves.

A single Hymenopterous parasite was bred from an imported onion fly puparium on August 31. On June 25, the parasitized onion fly larva pupated under laboratory conditions. Mr. J. C. Crawford, U. S. National Museum, identified this parasite as, "*Cothonaspis* n. subg." This is due, he states, "to its having only 11 joints in the antennæ instead of 12 or 13 as the various subgenera of Cothonaspis have. However, there is only one specimen, and he is loath to describe it as a new subgenus since occasionally these vary and this might be a specimen with abnormal antennæ." A number of specimens of another Hymenopterous parasite were bred from puparia obtained from larvæ which completed their development in radishes. This parasite was placed in the genus Cothonaspis by the same specialist. Mr. F. Knab, U. S. Bureau of Entomology, identified two species of Anthomyids which were bred from radishes, the seed-corn maggot (*Phorbia fusciceps* Zett.) and the cabbage maggot (*Phorbia brassicæ* Bouche).

In all probability, the last mentioned parasite attacks both species of Phorbia.

In the field onion flies which had succumbed to the effects of a fungus disease were frequently found adhering to onion leaves. In the laboratory the disease was spread to healthy flies confined in breeding jars.

IV Probable Causes of Enormous Increase of Imported Onion Fly

After a large number of commercial onion fields were visited and the methods employed by the growers were observed, it soon became evident that there are a number of reasons why the onion fly has increased to such enormous numbers in Wisconsin. The most favorable conditions for the multiplication of the pest rests in the fact that no steps are taken to destroy the maggoty onions in the fields. Most of the onion growers pay no attention to clean field methods.

As there was a low market for onions in the fall of 1912, many of the growers stored their seeded onions in warehouses over winter, with the expectation that a better price could be obtained in the spring. During the winter many farmers experienced difficulty with the onion rot (*Sclerotium cepivorum*) and all diseased onions were dumped on the land. In the spring there was no market for the onions and the bulbs were dumped and plowed under in the fields. One grower used 18,000 bushels as a fertilizer. Some of these onions sprouted early in the spring, offering the first brood of flies a most favorable opportunity to oviposit before the onion seeds germinated. It was common to see these onions growing here and there in sugar beet and potato fields. In fields where onions had been grown the previous year and where rotation of crops was practiced, hundreds of eggs of the pest were obtained by removing the soil in contact with the onion stems. An examination of the decaying bulbs plowed in the soil showed the presence of numerous maggots. Puparia were found in the soil beneath these decayed onions and the second brood of onion flies emerged from June 14–20; whereas, in the case of infested green onions under a cage in the field, the second brood issued from June 28 to July 25, most of the flies issuing from July 1–12.

When the onions are so seriously infested that the crop is not worth harvesting, the growers simply plow under the maggoty onions, thus giving the pests a most favorable opportunity to complete their life history.

During the marketing of the crop many infested, decayed and injured onions are thrown in the fields. In grading the onions, the men throw out of the screen all infested, decayed and injured bulbs.

These maggoty onions are allowed to remain in the fields thus giving the larvæ an opportunity to complete their development, bore into the soil to pupate and issue as flies.

The methods of harvesting seeded onions and onion-sets are different and have an important bearing on the destruction of the onion refuse. After the leaves of seeded onions ripen down and shrivel, the bulbs are removed from the ground. A few days later the leaves are cut off with grass shears and the tops are allowed to remain on the ground. After the onions have been removed from the fields, the tops and the maggoty, decayed, injured and under-sized onions can be accumulated in piles and burned.

In harvesting onion-sets the leaves are cut off with a lawn mower or grass shears before the bulbs are removed from the ground. The tops are gathered in windrows or piles and soon begin to decay. An examination of this decaying onion refuse showed the presence of numerous dipterous larvæ. Some of the growers labor under the impression that the onion waste will not burn. We have demonstrated to a number of farmers that no kerosene or fuel need be consumed if this work is properly carried out. The onion refuse left in windrows and piles will not burn, for it decays and becomes soaked with rain. If, on the other hand, this material is scattered in the field, the leaves lose what little moisture they retained during the ripening of the onion-sets, and then all the refuse can be accumulated in piles under favorable weather conditions and burned.

Too much emphasis cannot be expressed concerning the importance of clean field methods in the control of the onion thrips. When the onion tops become dry in the fields, the winged thrips leave the refuse and spread to the neighboring vegetation, reinfesting the onions when these are planted the following season. An examination of the onion tops several weeks after the crop was harvested showed the presence of numerous thrip larvæ beneath the sheaths of the onion leaves. These immature, wingless thrips would have been destroyed if the onion refuse had been burned immediately after the crop was harvested.

Many onion growers do not practice crop rotation. Some growers have planted onions on the same tract of land for a period of twelve successive years. Most of the onion growers in southeastern Wisconsin are not in favor of crop rotation, and grow onions on the same land year after year until the onion smut and insect pests render onion growing unprofitable.

Fall plowing is not practiced by many of the commercial onion growers in southeastern Wisconsin. In some cases the crop is barely harvested when about three carloads of Chicago stock yard manure to an acre is scattered over the onion refuse. Fall plowing would crush

many of the onion fly puparia and expose others to the sunshine and these, in all probability, would fail to hatch. Many puparia would probably be destroyed by natural enemies, such as birds and Carabids.

V Poisoned Bait Spray

Although seventy methods of fighting root maggots have been put on record, no attempt has been made to poison, with a sweetened spray, the adult before the egg-laying period begins. Under natural conditions the imported onion flies were observed feeding on wild and cultivated flowers, onion leaves and soil. In captivity *Phorbia cepetorum* relished diluted black-strap molasses, and they fed upon this sweetened liquid until their abdomens became greatly distended. If this insect is attracted to diluted molasses under natural conditions, the greediness of the flies for this sweet when poisoned, would be the weak point in the life history to attack the pest. If this poisoned bait be applied in the form of a spray to the onion leaves when the imagoes first appear on the wing and if the Anthomyids were to feed upon the insecticide no doubt large numbers would be killed before the egg-laying period commences.

A series of experiments were performed to determine the length of time that the imported onion flies would live in captivity when fed with diluted black-strap molasses to which had been added different kinds and amounts of insoluble poisons. Some of the flies were still alive at the end of a week in these experiments even though the poisoned bait was applied daily within the jars. The following proportions of molasses and water were used with each poison:

$\frac{1}{4}$ pint molasses.
1 or 2 ounces arsenate of lead, or zinc arsenite.
1 gallon water.

A series of similar experiments were now performed with different quantities of sodium arsenite, a soluble poison. One gram of sodium arsenite dissolved in a gallon of water sweetened with one-quarter of a pint of molasses, killed the onion flies within a day; in fact, a few specimens succumbed to the effects of the poison at the end of three hours. Too much emphasis, however, should not be attributed to any of these experiments, because the insects were in captivity and in feeding were forced to consume the poisoned bait.

In our field work, the first application of the spray was given to the onion leaves to control the second brood of flies on July 10, 1913. The poisoned bait was applied with a hand pump provided with a vermorel nozzle. The minute droplets of the spray adhered to the waxy coating of the onion leaves without a "sticker" being added to the poisoned

diluted molasses. After half an onion field was baited we were convinced that thorough spraying was not necessary, *as there was no question of doubt that the diluted molasses clearly attracted this pest.* In the sprayed portion of the onion field, numerous flies were seen on the onion leaves feeding on the minute droplets of this insecticide until their abdomens became greatly distended, but in the unsprayed part of the onion field, rarely was an Anthomyid seen exposed to the sunshine on the tops of the onion leaves. The following formula was used in this experiment:

Molasses	$\frac{1}{4}$ pt.
Sodium arsenite (dissolved in boiling water)	$\frac{1}{4}$ oz.
Water	1 gal.

Four applications of the spray were made to control the second brood of onion flies in this somewhat isolated onion field in which the pest had already destroyed 50 per cent of the crop. The bait was renewed once during each week.

On account of the severe thrip injury to the onion leaves in this field it was difficult to determine whether the waxy coating of the leaves insured protection from the burning of the soluble poison.

The results obtained were most encouraging in this somewhat isolated onion field for few infested onions were found compared with the ravages of the pest in some of the onion farms in the vicinity. As the season's work was started too late to test the effectiveness of the poisoned bait against the first brood of the pest, which is probably more difficult to combat on account of the frequent spring rains which wash off the spray, no conclusions can be drawn from the good showing that the spray made against the second brood.

To control the imported onion fly in a commercial onion field which is surrounded by other infested onion farms, may present a more difficult problem on account of the invasion of the pest from adjacent fields. It may be possible that if one grower sprays and his neighbors do not, that a few applications of the bait to the entire onion field followed by spraying of the margins adjacent to the unsprayed fields, may control the invading flies. This work must be continued during a number of seasons to determine whether the pest can be controlled in non-isolated onion fields.

VI Black Onion Fly (*Tritoxa flexa* Wied.)

According to Chittenden[1] the black onion fly (*Tritoxa flexa* Wied.) is "an old enemy of the onion and a native species, recorded from the

[1] Chittenden, F. H. Insects Injurious to Vegetables, p. 245.

Altantic coast to Illinois." Two black onion flies were taken by the writers in Milwaukee County, Wisconsin, on June 12, 1902. In the year 1913, nine of these insects were captured in Racine County, Wisconsin, and one specimen was bred from an infested onion on August 27. The black onion fly was not a serious pest of the onion in the season of 1913.

VII Barred-Winged Onion Fly (*Chætopsis ænea* Wied.)

The barred-winged onion fly (*Chætopsis ænea* Wied.) was bred from decaying and also smut-infected onions.

VIII Euxesta notata Wied.

Another Ortalid (*Euxesta notata* Wied.) was commonly reared from decaying and smut-infected onions and from piles of decaying onion tops. The maggots of this insect were often found feeding in company with the larvæ of the imported onion fly or in decaying or partially decayed onions which the latter had deserted.

IX Onion Thrips (*Thrips tabaci* Lind.)

The first noticeable injury to onion plants caused by the onion thrips (*Thrips tabaci* Lind.) was observed at the end of June. At this time thrips were especially abundant between the two central or innermost leaves. Considerable alarm was expressed by the onion growers during the prolonged hot dry spell at this time of the year, as enormous numbers of the pest began to appear in the onion fields. On July 4, the dry spell was broken by a driving rain which according to the statements of the commercial onion growers, "destroyed great numbers of the insect and saved the onion crop." In the month of August, however, the leaves showed severe thrip injury, namely, the whitened appearance of the leaves produced by the rasping and sucking mouth-parts of the insects.

X Cutworms

Cutworms caused a slight amount of injury in the onion growing districts near Racine, Wisconsin, in 1913. The damage to onions by these pests was principally the work of the spotted cutworm (*Noctua c-nigrum* Linn.) and the variegated cutworm (*Peridroma saucia* Hbn.). The spotted cutworm was so heavily parasitized by a parasite, *Apanteles* (*Protapanteles*) sp. in 1913, that but little injury was caused to the onions by the pest.

XI Miscellaneous Insects Injurious to Onions

Among the miscellaneous insects injurious to onions observed occasionally in the onion fields were the following: Zebra caterpillar

(*Mamestra picta* Harr.), yellow-bear caterpillar (*Diacrisia virginica* Fab.), white-lined sphinx (*Deilephila lineata* Fab.), tarnished plant-bug (*Lygus pratensis* Linn.), and twelve-spotted Diabrotica (*Diabrotica 12-punctata* Oliv.).

XII Insects Bred from Decayed Onions

A number of insects breed in onions after the imported onion fly larvæ have caused decay. Stable fly (*Stomoxys calcitrans* Linn.) larvæ were found feeding in company with the imported onion fly maggots, or in decaying onions which the latter had deserted. The adults were often reared under field and laboratory conditions.

Glischrochilus (*Ips*) *fasciatus* Oliv., and its larvæ were observed feeding in decaying onions, which were or had been infested with the imported onion fly larvæ. The beetle and its larvæ were commonly found in decaying onions which had been plowed under as a fertilizer.

NOTES ON THE BROWN LACE-WING[1]

(*Hemerobius pacificus*, Bks.)

By Geo. F. Moznette, *Oregon Agricultural College*

A study of the above species was begun in the early part of November, 1913, and numerous observations have been made in the field, while breeding experiments have been conducted in the laboratory.

This species, a member of the order *Neuroptera*, is of considerable economic importance in that it is predaceous in its larval stage upon the *Aphididæ* or plant lice, *Acarina* or mites, and probably other soft-bodied insects. It was found to be particularly important in destroying the oviparous females of the Rosy Apple Aphis, *Aphis sorbi* Kalt., and the Currant Aphis, *Myzus ribis* Linn. However, this species preys upon almost all species of *Aphididæ*, and during July, 1913, it was found quite abundant in hop yards feeding upon the wingless females of the summer generations of the Hop Aphis, *Phorodon humuli* Schrank, and also on the Red Spider of the Hop, *Tetranychus telarius* Linn.

Specimens in the college collection are recorded from Vale in eastern Oregon, and Corvallis and Oregon City in western Oregon. It is an important economic species in California, and is also found in the states of Washington, New Mexico, Arizona, and the province of British Columbia. We can then assume that it is distributed over the Pacific Coast regions.

[1] This article is published with the permission of Prof. H. F. Wilson as a contribution from the Entomological Department of the Oregon Agricultural College.

The determinations of the Aphids used were made by Prof. H. F. Wilson to whom I am also indebted for suggestions in this work. The determination of the lace-wing was made for this department by Mr. Nathan Banks, of the United States National Museum, Washington, D. C. He described this species in his paper entitled New North American Neuropteroid Insects, Transactions of the American Entomological Society, XXIV.

On November 3, 1913, numerous eggs and larvæ were found among colonies of *Aphis sorbi* Kalt. on apple trees in the experimental orchard of the Oregon Agricultural College. The eggs are laid singly on the lower surface of the leaves. They may be found placed indiscriminately over the lower leaf surface, but most of them are deposited next to the midrib, lateral vein or in the axil of the two. They are laid horizontally or on end, usually the former.

The egg is ovoid, white, changing to a light amber in the course of development and growth, and measures .92 mm. in length and .40 mm. in width. The surface is reticulated and at one end is located a small disc-shaped micropyle.

On November 29, 1913, a number of apple leaves free from eggs were tagged on a small apple tree. Many eggs were found in the orchard on this date. The tagged leaves were observed each day and December 1, 1913, three leaves were found each with a single egg. These leaves were placed in vials to ascertain the incubation period. The eggs developed, and hatched on December 10, 1913, the duration of the egg stage being nine days.

The newly hatched larva is somewhat different from that of the mature larva in that it is distinctly white in color, and the mouthparts are much more prominent than in the later instars. The eyes are a faint brown. It measures 2 mm. in length. Upon hatching, the larva emerges from the egg at one end, and remains motionless for a very short period, after which it immediately becomes very active in search of food.

The larva moults three times, twice before spinning its cocoon and once just before it transforms to the pupa. The third larval exuvium is found in the cocoon. I have observed that the larvæ of *Hemerobius pacificus* develop much more rapidly in warm than in cool weather. Under the latter conditions, they seem to become more sluggish and show a reluctance to feed. The larvæ did not show any real disposition to cover themselves with Aphis skins, though they frequently became entangled in the hairs and feet, and were involuntarily carried about.

The larvæ were supplied with an abundance of Aphis, consisting of *Aphis sorbi* Kalt., *Macrosiphum lycopersici* Clark; and *Amphorophora*

lactucæ Kalt. The latter is very common in the fall on a species of milkweed around Corvallis, Oregon. On approaching an Aphis the larva makes a quick dart for it, inserts its piercing mouthparts, and sucks the blood from the victim.

The accompanying table gives some data on the life history of three of the larvæ.

DURATION OF THE VARIOUS STAGES

Larva No.	Hatched	1st moult	2nd moult	3rd moult	Pupated	Emerged
1.............	Nov. 23, 1913	Nov. 26, 1913	Nov. 28, 1913	Dec. 7, 1913	Dec. 7, 1913	Dec. 21, 1913
2.............	Nov. 11, 1913	Nov. 15, 1913	Nov. 20, 1913	Nov. 22, 1913	Nov. 22, 1913	Dec. 8, 1913
3.............	Nov. 22, 1913	Nov. 26, 1913	Nov. 28, 1913	Dec. 6, 1913	Dec. 6, 1913	Dec. 21, 1913

The duration of the larval stage and instars varies considerably according to the nature and quantity of the food supply and the rapidity with which it feeds. Also the temperature. The larval period was found to average fourteen days.

The larva is sort of spindle-shaped, tapering toward the caudal end. The mature larva measures 7.5 mm. in length. The head is strong and bears large sharp curved grasping and blood sucking mouthparts. The antennæ are composed of three annulated segments, the rings being very close together and not distinct so that several cross lines occur connecting the different rings. The eyes are dark brown and almost black. A dark brown line runs through the eyes as well as the center of the head. The legs are whitish and the feet possess suckers which are sort of bell-shaped and located between the claws. The abdomen is light amber in color with darker markings. On each side of the dorsal aspect there is a discontinuous line, each thoracic, and the first few anterior abdominal segments possessing an irregularly shaped marking, brown in color. These markings are intersected by the thoracic and abdominal sutures. There is also a line which runs down the center of the dorsum from the head to the cauda. The underneath parts are pale amber colored fading to a whitish color approaching the sides. The larva is slightly pubescent. The sucker at the caudal end of the abodmen is used, as in the case of the larvæ of the *Coccinellidæ*, for anchorage.

When ready to pupate, the larvæ as a rule seek some crevice in the bark, although cocoons were found in clustered leaves of apple curled by Aphis, and on the under surface of the leaves of currant and hop vines. Anthracnose cankers on trunks and limbs of apple trees make desirable places for hibernation. Each larva upon finding a suitable place immediately begins to construct a very thin, loosely woven cocoon. When the cocoon is constructed it continues contracting, moults for the last time and pupates. The cocoon is 5 mm. in length.

The pupa is a light brown in color, the thoracic and abdominal regions bearing the same characteristic markings as are found in the larva. It is somewhat cylindrical in shape curved and with the limbs and wings folded to the breast. The wing pads are at first white changing to a light amber in color. The antennæ are now more or less clavate, the segments not distinctly bead-like. The eyes are very prominently black. It measures 4 mm. in length.

The insect on emerging from the cocoon ruptures one end, and the pupa apparently cuts its way out of the cocoon as the pupal skin is cast outside. The length of the pupal stage is fifteen days.

The adult is distinctly light brown in color, lighter at first, changing gradually to a darker shade and is covered with short hairs. The head is small and pale in color. The eyes are prominently black. There is a brown band below each eye. The antennæ are moniliform or bead-like in form. There is a brown line at the base of each antenna. They are pale amber in color. The thorax is pale and hardly brown. The legs and abdomen are a little darker. Wings hyaline, the venation is somewhat pale marked with brown spots which are darker at the base, rising from these spots are indistinct oblique clouds. The gradate veins are mostly brown clouded forming an indistinct band. Along the border are groups of brown spots and the pterostigma is indistinct. The costal space is narrow toward the base and the median is much bent toward cubitus at connecting veinlets. Three radial sectors, the upper branch of the third forked before the inner gradate series, lower simple. Last gradate veinlet of inner series is distinctly beyond the previous one. Hind wings white with pale veins except few outer gradate ones. Expanse 18–21 mm.

When at rest, which is usually during the day, the wings are held roof-like over the body. I have observed but few on the wing during the day and then only when disturbed from their place of rest. Their flight is slow and sluggish. When confined in breeding cages they do not live more than three or four days.

Records of the feeding of five *Hemerobius* larvæ are given as follows:

Aphids Eaten by Hemerobius Larvæ

Larva No.	Hatched	Number Aphids Devoured per Day									Total Aphids Devoured	Average per Day
		Dec. 11	Dec. 12	Dec. 13	Dec. 14	Dec. 15	Dec. 16	Dec. 17	Dec. 18	Dec. 18–19–20 in Cocoon but not Pupa until Dec. 22–23–24		
1.....	Dec. 10	10	26	24	25	26	24	29	32	....	196	24
2.....	Dec. 10	13	27	28	27	29	23	28	29	....	204	25
3.....	Dec. 10	19	29	28	29	30	25	26	30	....	216	27
4.....	Dec. 10	12	26	27	28	25	24	28	31	....	201	25
5.....	Dec. 10	10	23	23	24	26	23	29	33	....	191	24

In studying this species, the experiments were conducted under laboratory conditions where the temperature varies. Temperature readings during day were between 60–80 degrees and during the night between 40–50 degrees Fahrenheit. Observations were made on forty-seven eggs, twenty-two hatched and transformed into adults. The life cycle according to observations under these conditions required an average period of thirty-eight days.

Explanation of Plate 15

No. 1. The egg in situ on leaf. (Much enlarged.)
2. Cocoon. (Much enlarged.)
3. Pupa. (Much enlarged.)
4. Larva. (Much enlarged.)
5. Adult. (Much enlarged.)
6. Cocoon with top dissected away to show pupa. (Much enlarged.)
7. Showing pupa encased in cocoon. (Slightly enlarged.)

THE MOUTHPARTS OF THE THYSANOPTERA AND THE RELATION OF THRIPS TO THE NON-SETTING OF CERTAIN FRUITS AND SEEDS

By Arthur D. Borden, *Pasadena, California*

The asymmetry of the mouthparts of the Thysanoptera has been known for a long time, and a number of papers have been published describing in more or less detail the general characters of the mouthparts. In the present paper is presented a detailed account of the mouth structure of the thrips based on a considerable comparative study of the mouthparts. It also includes some observations on the feeding habits and on the damage done by certain of the economically important species. As examples of what serious pests are contained in this group of insects, there need only be mentioned the pear thrips (*Euthrips pyri*), the wheat thrips (*Euthrips tritici*), the orange thrips (*Euthrips citri*), the grass thrips (*Anaphothrips striatus*), the onion thrips (*Thrips tabaci*), the tobacco thrips (*Euthrips fuscus*), the greenhouse thrips (*Heliothrips hæmorrhoidalis*), and the bean thrips (*Heliothrips fasciatus*). Nearly all of these are recognized as pests in the state of California.

The earliest considerable description I have been able to find of the mouthparts is that of Karl Jordan (1888), on *Parthenothrips dracænæ*, a fairly accurate description and quite well illustrated. Then came the account of H. Garman (1890), on *Limothrips cerealium*, who points out the error in considering the articulated lobes of the maxillæ as the mandibles, and suggests that the unpaired organ is truly the mandible. In 1891 J. Bohls published as a doctor's dissertation at

Brown Lace Wing

Göttingen an account of the mouthparts. Then follows the account in Uzel's Monograph (1895) in which Uzel adopts Garman's views as to the structure, excepting that he differs with Garman in regard to the mandibles, Uzel holding that the lobes of the maxillæ are the mandibles and calling the mandible of Garman the epipharynx. Garman again presented his theory, in the *American Naturalist* (1896), and offered a strong argument to support his views. In 1899, Pietro Buffa, an Italian, described the structure of *Heliothrips hæmorrhoidalis*, giving a fairly accurate description, although his illustrations are confusing. Finally, in 1902, W. E. Hinds gave a very good description of the structure of the mouthparts of *Anaphothrips striatus*, but his figure is at most only diagrammatic. Very little comparative work had been attempted before the work of Hinds.

The present work is based on studies made of representatives of all three families of the Thysanoptera, including twelve of the genera and some twenty odd species. The material was all collected in the Santa Clara Valley, California. The method employed in collecting and preparing was as follows: The thrips were collected and killed by dropping them directly into 70 or 80 per cent alcohol; dehydrated by passing them successively through 90, 95 and absolute alcohol, then cleared in xylol and mounted in balsam. As soon as mounted, the mouthparts may be separated out by carefully pressing and moving the cover slip with a needle, under the low power of the compound microscope, until it can be seen that the parts are sufficiently separated. In some cases the specimens were cleared by boiling in KOH a few seconds before mounting.

The work and preparation of this paper were carried on in the Entomological Laboratory of Stanford University.

The Mouthparts

The mouthparts of the thrips appear as a broad unjointed cone attached to the extreme posterior edge of the under side of the head and carried so far back that it lies largely under the pronotum when at rest. The apex of the cone is usually quite sharp, as in many of the Phlœothripidæ, in which case the separate parts are longer and more tapering than where the tip of the cone is more blunt, as in many of the Thripidæ. The shape of the cone is not of the same type throughout any one large group or even for the different families, but varies greatly even for the different genera in the same family.

In the suborder Terebrantia, the mouthparts are connected to the frons by a strongly chitinized thickening rounding the head (Pl. 16, figs. 1, *e* and 2, *e*) which is more or less oblique on the front of the head. In this suborder there is also a strongly chitinized thickening extending

from this circular band to the left eye (Pl. 16, figs. 1, *b* and 2, *b*) and a rudiment of one under the right eye (Pl. 16, figs. 1, *a* and 2, *a*). At each side of the head and extending a short way down the side of the mouth cone is a peculiar curved spine which may possibly serve as a strengthening rod to the side of the cone (Pl. 16, fig. 2, *d*). The suborder Tubulifera has the connection with the eye wanting.

The general makeup of the mouthparts of the different species is quite similar, the greatest difference occurring in the shape of the parts in those species where the cone is blunt instead of sharp. In the former case, the separate parts are heavier and broader and necessarily shorter. There is also some difference in the number of segments of the labial and maxillary palpi, as will be noted later. The mouthparts of the young are similar to those of the adult, though less strongly chitinized.

As to the asymmetry of the mouthparts, I have adopted Garman's views and consider the unpaired organ on the left side as the mandible. The labrum and the clypeus also show asymmetry and these will be discussed separately.

Labrum.—The labrum (Pl. 16, fig 1, *l*) forms the front of the cone and is asymmetrical in all the thrips. It is composed of two segments closely united and is distinguished from the clypeus (Pl. 16, figs. 1, *c* and 2, *c*) by a membranous connection. It is long, slightly curved and bears at the tip a round socket through which the stylets pass (Pl. 16, figs. 3 and 3, *a*). So far as I know, this condition has not been pointed out before. The labrum is drawn out on the right side and nears the edge of the clypeus. The clypeus is decidedly asymmetrical and curves high on the left side, thus forming the broad part of the membranous connection between it and the labrum.

Maxillæ.—The maxillæ (Pl. 16, figs, 1, *g* and 4) form the side walls of the mouth cone. They are triangular in form, and taper strongly towards their tips which fit closely about the tip of the labrum. About the middle of the maxillæ are borne the maxillary palpi (Pl. 16, fig. 4, *b*) which bear a few tactile hairs. The maxillary stylets, or lobes (Pl. 16, figs. 1, *i* and 4, *i*), are borne at the top and are jointed, being composed of a short stout arm and a long tapering stylet. By lowering the angle of the short arm with the main part of the maxillæ, the stylets are thrust out. The segments in the maxillary palpi differ greatly in number and shape with different genera, even in the same family. For example, in the family Aeolothripidæ, members of the genus Orothrips have seven segments, of the genus Erythothrips eight segments, and of the genus Aelothrips three segments. The usual number in the family Thripidæ is three although often only two occur. In the family Phlœothripidae the usual number is two.

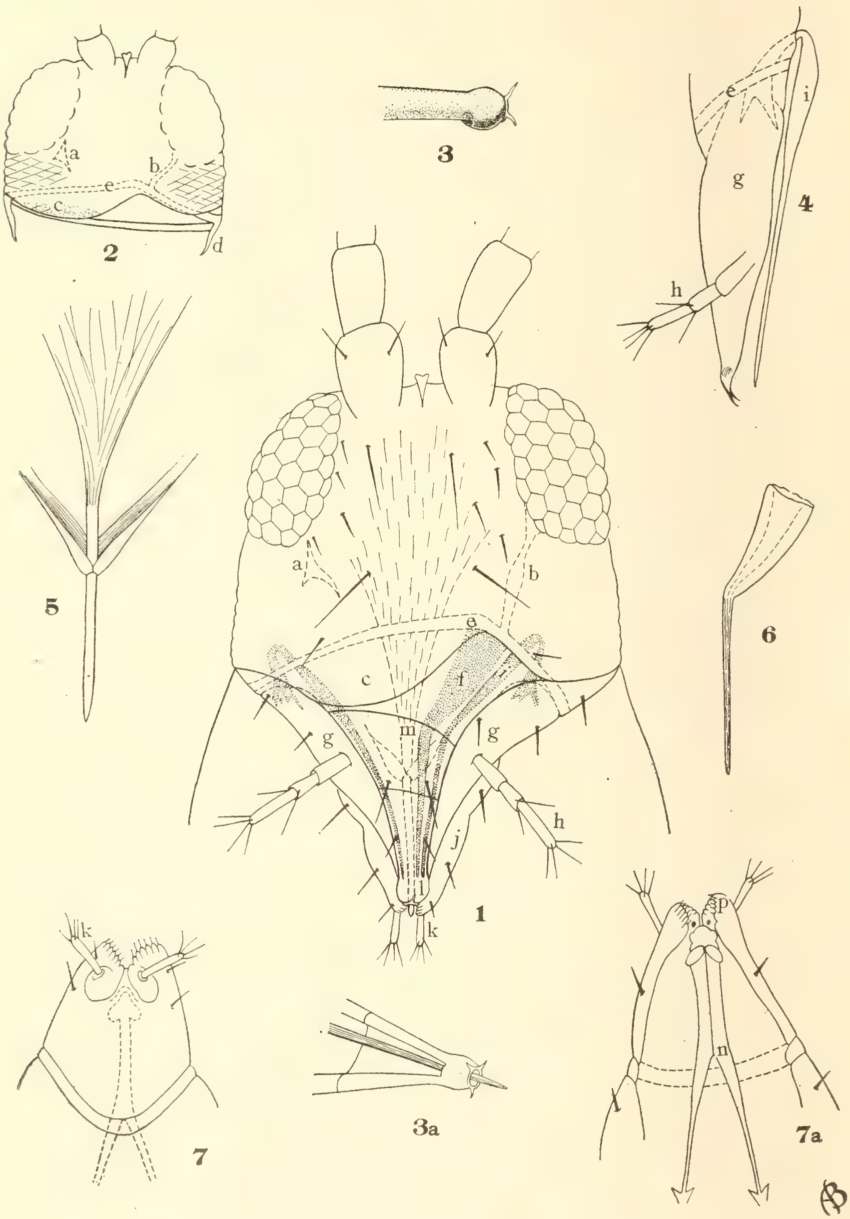
The segments may be short and stout, as in the genus Orothrips, or they may be long and cylindrical as in many of the genera of the Thripidæ.

Labium.—The labium (Pl. 16, figs. 1, *a*, 7 and 7, *a*) forms the hind wall of the mouth cone. Where the mouth cone is blunt, the labium is usually very broad and heavy, and where the mouth cone is sharp, the labium is narrowed. The labial palpi (Pl. 16, figs. 1, *k* and 7, *k*) are borne near the tip, and the very tip of the labium is lobed and bears a tactile hair on each tiny lobe. There is a strong chitinous bar (Pl. 16, figs. 7, *a–n*) extending down near the median line of the labium which divides near its base and ends in two peculiar, spear-shaped parts. This bar is undoubtedly a strengthening device for the fleshy labium. The labial palpi differ as greatly as do the maxillary palpi within the different families. In the Phlœothripidæ they are usually described as having but one segment and in the Thripidæ usually two, while in the family Oelothripidæ the genus Orothrips bears five segments and the others but four. In most Thripidæ that I have examined there seems to be but a single segment composing the labial palpus.

Within the hollow of this mouth cone we find the maxillary stylets already described, the single mandible on the left side, and an organ which I have taken to be the hypopharynx.

Mandible.—This is a large, strongly chitinized, styliform organ on the left side (Pl. 16, fig. 1, *f*) and joined by its broad base to the chitinous band in the frons just where the connection is made with the bar running to the left eye. The mandible is peculiarly fitted to this side of the head, and I have been unable to find anything corresponding to it on the right side, though several authors have described a rudimentary part. Although the mandible may differ slightly in shape in the different groups, the structure is essentially the same throughout. It is made up of a bulbous chitinous base with a strong muscular attachment and a long sharp stylet slightly angled at its base.

Hypopharynx.—Just below the mandible and on the base of the mouth opening, viewing the mouthparts from the front, is a large styliform organ passing through a groove or socket (which is attached to the floor of the mouth opening) and with a strong muscular attachment reaching well up under the frons of the head. This I take to be a hypopharynx. It has been only partially described before. Jordan describes the upper section and suggests that it is a hypopharynx; Buffa describes it in part and also figures an epiglottis; Hinds simply mentions it but does not attempt to describe it. In none of the accounts has it been described as styliform as I have found it in my preparations. This I take to be used much as is the mandible in feeding.



Euthrips tritici

Observations on Feeding Habits

The mouthparts of the Thysanoptera are probably used almost entirely for sucking although they have been repeatedly described as intermediate in form between those of sucking and chewing insects. In feeding, the insect begins by a forward and backward movement of the head and by this sort of rasping movement punctures the epidermal cells of the plant tissue. It then lowers its head and begins to suck up the plant juices. It remains here until the punctured cells are nearly emptied when it moves on a bit and repeats the operation. From the structure of the mouthparts it appears that the strong mandible and possibly the hypopharynx are used in breaking the cells of the tissues, while the finer stylets of the maxillæ are using in lancing the softer tissues. The tip of the labrum placed over the puncture forms a close connection and the juices are easily sucked up into the mouth. The whole mouth cone is fitted for sucking and most likely the food is almost entirely plant juices. I have made observations on the greenhouse thrips, *Heliothrips hœmorrhoidalis* and *Parthenothrips dracœnœ* on leaves of a greenhouse plant, and also on *Euthrips pyri*, the pear thrips, on fruit blossoms, as well as *Euthrips tritici* and *Euthrips occidentalis* on alfalfa blossoms. The feeding habits of the young are similar to those of the adult.

Results of Feeding on Deciduous Fruits

On the deciduous fruits the thrips feed on the tender floral parts (the tips of the petals of the opening buds and later on the inner floral parts including the tender stigma) with very damaging results to the setting of the fruit, where the insects occur in any great numbers. The injured tissues at first turn brown and later black, often resulting

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Explanation of Plate 16

Fig. 1. Head of *Euthrips tritici: a*, rudiment of chitinous band to right eye; *b*, chitinous band to left eye; *c*, clypeus; *d*, chitinous band under frons; *f*, mandible; *g*, maxilla; *h*, maxillary palpus; *i*, maxillary stylet; *j*, labium *k*, labial palpus; *l*, labrum; *m*, hypopharynx.

Fig. 2. Same with mouth parts removed: *a*, rudiment of chitinous band to right eye; *b*, chitinous band to left eye; *c*, clypeus; *d*, curved spine from chitinous band; *e*-chitinous band.

Fig. 3. Tip of labrum, side view.

Fig. 3a. Tip of labrum, under-side showing stylets in position.

Fig. 4. Maxilla: *e*, part of chitinous band; *g*, main part of maxilla; *h*, maxillary palpus; *i*, maxillary stylet.

Fig. 5. Hypopharynx removed, showing socket and muscular attachment.

Fig. 6. Mandible removed.

Fig. 7. Labium ventral side.

Fig. 7a. Labium dorsal side, showing chitinous rod (*n*).

in premature falling of the flower before setting of the fruit. In the Santa Clara Valley I have examined peach blossoms which contained a great number of thrips and even before the fruit had had a chance to set the damage was so serious that by gently stripping my hand down a twig nearly every blossom would fall. The almonds, the first crop to blossom, are damaged to a slight extent where the thrips occur in numbers, but the prunes, plums, peaches, apricots and cherries, which follow in rapid succession, are the fruits which are damaged the most. This had been an unusual spring (1913) for thrips and they have done serious damage to crops in the Santa Clara Valley. One orchardist estimated that nearly two-thirds of the "set" on his peach orchard was destroyed by thrips this year. These trees are commonly infested with *Euthrips pyri*, *Euthrips occidentalis*, *Euthrips tritici*, and *Oelothrips kuwanaii*, though *Euthrips pyri* occurs in much the greater numbers.

Damage to Alfalfa Grown for Seed

On alfalfa I have collected quantities of *Euthrips tritici* and *Euthrips occidentalis*. Though alfalfa is not grown for seed in the Santa Clara Valley, I have had a chance to observe the work of the thrips, as the insects occur in considerable numbers there. The damage here is much the same as in the flowers of the deciduous fruits. The young floral parts are attacked, and the damage results in the premature falling of the flower or the young seed pod. Though the ovary is very pubescent I have observed thrips feeding about the base and also along the tender stigma. Often I have found specimens of alfalfa where nearly all the small pods had dropped from the main stem and only a few remained near the tip. Where this damage could not be directly traced to the feeding of *Diabrotica soror*, and the thrips were present in great numbers, the damage was most likely the result of thrips attack.

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FURTHER EXPERIMENTS IN THE CONTROL OF THE TARNISHED PLANT-BUG

Lygus pratensis Linn.

By M. D. Leonard, *Ithaca, N. Y.*

In June, 1914, Professor C. R. Crosby[1] and the writer published a bulletin on the tarnished plant-bug, in which were recorded the results, all negative in character, of experiments performed in a nursery near Rochester, N. Y., where the insect has been very destructive to peach stock. The conclusion was reached by the writers that:

"The foregoing experiments show that it is doubtful whether the injuries to peach nursery stock by the tarnished plant-bug can ever be prevented by the use of deterrents, or whether the adult bugs can be killed under actual field conditions by any contact insecticide now at our disposal. Catching the bugs by mechanical means has thus far been unsuccessful. Furthermore, either catching or killing the bugs in the nursery would be of very little value in protecting the trees, because of the invasion of the blocks by swarms of bugs from adjoining fields. It would seem that the only feasible means of preventing the injury to the trees would be either by excluding the adults from the nursery blocks by a wire screen fence, or by enclosing the tips of the terminals in bags during the period in which most of the injury is inflicted. It might also be possible to prevent some of the loss from this cause by assisting the trees to outgrow the injury by proper pruning and cultural methods." (Crosby & Leonard, 1914:497.)

The suggestions for future experimental work contained in the above statement were followed out in the same nursery during the past summer and it is the results of these experiments which are presented in the present paper.

Fencing

In order to thoroughly test the efficiency of excluding tarnished plant-bugs from the nursery blocks by means of a fence, an experiment was carried out using wire screen cloth on a much larger scale than that of the previous summer. It had been our experience during the seasons of 1912 and 1913 that the insects did not appear on the peach stock in any considerable numbers till about June 23, and that then,

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[1] I wish to express my thanks to Professor Crosby, under whose direction the work outlined on this paper was done, for assistance in planning and carrying out the experiments.

within a few days, their numbers increased rapidly. Accordingly, in order to have the fence up and in working order by that date, its erection was commenced on the fifth of June. Ordinary wire screen cloth 6 feet wide was used to enclose a rectangular area 470 feet by 240 feet which therefore contained 2.59 acres. This enclosure was placed in a 13-acre block of peach "buds." A narrow strip of ornamentals bordered the fence on the west side; the other three sides were surrounded by peaches.

Hickory posts 9 feet long were sunk 2 feet into the ground at intervals of 10 feet. The wire screen cloth was then fastened to these uprights with heavy staples. In order to prevent any insects from crawling through open spaces at the bottom due to irregularities of the ground, the dirt was banked up firmly 3 or 4 inches at the base. At one corner a flap of the wire was arranged so that it could be opened in order to admit teams and workmen. Since the rows ran north and south, on the inside at the north and south ends the trees were dug out for a distance of about 10 feet in order to provide a turning place for the mules and cultivator.

It had been previously observed that though the tarnished plant-bugs did not actually fly over the fence from the surrounding weeds or nursery stock they would, however, fly onto the fence, crawl to the top and then fly into the enclosure. In order to prevent this a strip of O. & W. Thum's Tree Tanglefoot about 4 inches in width was applied along the upper edge of the wire cloth. The method of application was as follows: Two men worked together, one on each side of the fence. Wooden paddles were used, the ends of which were cut at an angle and bevelled. The tanglefoot was applied from the outside and pressed back and forth until a uniform thickness of about 1/10 inch was obtained, the man on the inside always finishing so that the greater part remained on the outside of the wire cloth.

It took two men about an hour to put on such a band of tanglefoot 100 feet in length. A pail of tanglefoot containing about 25 pounds covered about 300 linear feet.

In another part of the nursery in which about 13 acres of peach seedlings were planted, a similar fence was constructed but the enclosed area was much smaller, the dimensions being 190 feet by 100 feet. Most of the observations were made, however, at the larger enclosure as it was nearer to the laboratory. This enclosure was completed on the 12th of June and the smaller on the 16th.

The cost of construction of the two fences together, including materials and labor is shown in the following statement.

Cost of Construction

2,000 linear feet wire screen cloth, 72 inches wide, 12 meshes to the inch, at $1.70 per hundred square feet	$204.00
Tanglefoot, 175 pounds	30.00
Poles used for uprights, 200 at 5¢ per pole	10.00
Materials and labor	
Construction of fence, 145 hrs. at 20¢ per hr	29.00
Applying tanglefoot, 40 hrs. at 20¢ per hr	8.00
Mounding dirt at bottom, 5 hrs. at 20¢ per hr	1.00
Total	$282.00

The peach blocks were first examined on June 4 and at that date a tarnished plant-bug nymph in the third instar was found. On June 6, two adults were captured. On June 9, two adults were taken inside the enclosure and four outside; the following day two inside and none outside, and on June 10, two inside and one outside.

In order to determine whether tarnished plant-bugs were getting over the fence into the enclosure, careful counts were made at short intervals. There were 66 rows inside the enclosure, each about 450 feet in length. An equal distance was measured off on these same rows immediately south of the enclosure as a check plot. Every eighth row was selected and the number of tarnished plant-bugs occurring on each row recorded. The insects were caught by walking along the rows and sweeping the trees with an insect net. The following table is a record of these counts made from June 15 to July 24.

[Table Showing the Number of Tarnished Plant-Bugs Caught per Row in the Peach Blocks

Enclosure

June	15	17	18	22	23	25	26	30	Jy. 4	7	9	14	15	18	24
Row 1...	2	1	1	4	4	7	20	4	15	4	9	20	32	6	19
9...	0	0	1	3	0	4	6	4	11	12	23	25	22	3	22
17...	0	0	0	0	0	6	12	11	14	36	54	61	44	10	12
25...	0	0	0	0	3	5	12	13	21	76	112	60	50	25	13
33...	0	0	0	4	2	1	7	12	20	18	26	46	50	14	12
41...	0	0	0	0	6	3	6	4	17	13	26	29	60	17	25
49...	0	0	0	2	3	11	10	17	12	30	39	72	50	28	15
57...	1	0	0	2	2	6	11	23	31	78	78	81	59	22	11
65...	2	0	1	0	7	11	13	30	21	47	27	62	47	25	20
Total.....	5	1	3	15	27	54	107	118	162	314	394	456	414	150	149

Check Plot

Row 1...	2	0	4	7	8	12	7	9	18	10	20	51	45	9	10
9...	0	0	2	6	2	20	6	17	21	6	62	111	60	30	16
17...	1	1	1	9	4	8	18	24	37	11	77	108	62	47	18
25...	2	0	6	5	9	34	24	34	24	46	78	87	88	26	30
33...	0	2	2	7	6	40	15	25	33	80	112	61	62	24	20
41...	1	1	2	20	7	32	21	29	54	29	150	123	125	34	17
49...	1	2	7	22	9	31	17	32	37	67	124	150	84	33	12
57...	0	0	0	17	4	18	12	25	53	99	146	140	67	8	22
65...	0	1	3	19	9	31	18	42	70	100	185	136	169	27	21
Total.....	7	7	27	112	58	226	138	237	347	448	953	967	762	238	166

It was at first proposed to count, at intervals of several days, the number of injured terminals on six rows inside the enclosure and on six rows of equal length on the check plot outside of the enclosure. The number of trees in each of these rows was therefore counted and the percentage of injured terminals was to be determined. The number of injured terminals was counted at intervals of 3 or 4 days but it was found that by the twenty-ninth of July about 75 per cent of the trees on the inside of the enclosure and of those in the check plot had been stung and the counts were discontinued. The number of injured trees increased at about an equal rate in both the enclosed and the check plot. The nursery was visited again on November 8 and there was about 95 per cent injury both inside the enclosure and on the check plot.

At the time the fence was erected the number of tarnished plant-bugs which had appeared in the nursery blocks was negligible. By examining the totals in the above table it may be seen that during the period in which it was under observation the fence did keep out many of the tarnished plant-bugs, in some cases over 50 per cent, but from the final condition of the trees inside the enclosure as seen on November 8 not enough had been excluded to make its use worth while.

The behavior of these insects on the fence was carefully observed from day to day. It was found that very few of the bugs would alight on the fence higher than three feet from the ground. They would then make their way to the edge of the tanglefoot by walking or by a series of flights of six or eight inches each. From this point it required but a short flight to carry the insect over the width of the tanglefoot and into the enclosure. Some, of course, did not act in this manner but after walking or flying about a little returned to the weeds or peach trees.

Although the tanglefoot band soon became filled with insects of many kinds—flies, beetles and bugs, it was noticed that practically no tarnished plant-bugs had been captured. Time and again these insects were seen to either crawl or fly onto the tanglefoot, walk about upon it, and then either crawl back onto the wire cloth or proceed to the top of the band and fly into the enclosure. This was not due to the fact that the tanglefoot did not remain sticky for it caught other insects constantly. But one tarnished plant-bug was observed to crawl through the meshes of the wire cloth and this one only when a cyanide bottle had been placed over it.

On November 8 the peaches were examined and when the enclosed block and the check block were compared as a whole no difference could be seen in the growth of the trees as affected by the tarnished plant-bug.

Bagging

When the tip of the leader on a peach nursery tree is "stung" by the tarnished plant-bug the upward growth of the tree is checked, the nourishment is thrown into the laterals, and a short bushy tree which has lost much or all of its market value is the result.

In July and August, 1913, preliminary experiments were performed in protecting the terminals of the peach trees from tarnished plant-bug injury by placing paper, mosquito netting and cheese-cloth bags over them. From the results obtained it seemed that it might be feasible to protect the tips by means of five-pound unglazed paper bags without injury to the foliage. Accordingly on June 18, 1914, before any of the tips had been stung, row 15 south and west of the fenced enclosure consisting of about 450 trees, was bagged with five-pound unglazed paper bags. These were placed over the tips so as to leave about three inches between the tip of the leader and the bottom of the bag in order to allow for some growth. The bags were folded once at the bottom so as to close the opening as completely as possible and fastened together with two pins. It was found that one man could put on 100 bags in slightly less than an hour.

On June 26 these bags were examined and it was seen that as the tips of the young trees were still tender they were being bent far over to the east, due to the weight of the bags and the constant west winds which continually blow over the nursery blocks. On this date 300 bags were placed on trees in the first row west of the enclosure.

On June 30 all the bags were removed as it was found that they were impeding the growth and destroying the shape of the trees. On row No. 1 the foliage under the bags was somewhat cramped, though not greatly so as they had been on only four days. The tips, however,

were badly bent over to the east and several were broken off. On row No. 5 in most of the cases in which the pins had not been stuck through several leaves the bags had been blown off. Those bags which still remained on the trees had bent the tips over at right angles or even farther. It was evident that it was wholly impracticable to place bags over the terminals at this date because they were as yet too tender to stand the strain due to the weight of the bags in the wind. This method of protecting the peach trees from the attacks of the tarnished plant-bugs was, therefore, abandoned.

Pruning

Phillips (1906) described a method of pruning to overcome a similar trouble of peach nursery stock. Although he attributed the injury to an undetermined species of mite, the system of pruning recommended by him would apply equally well if the injury were caused by the tarnished plant-bug. His experiments are as follows:

"He attempted to assist the tree to outgrow the injury by judicious pruning in May and June. On May 18, injured trees were pruned by pinching off the terminal bud, which had ceased to grow, giving one of the side shoots near the tip an opportunity to push up almost straight. The tips of the other laterals were also pinched off so as to throw the growth into the bud that was left at the top. On August 15 an examination showed that of the pruned trees, 68 per cent and 73 per cent of Wonderful and Champion, respectively, had grown straight. Unfortunately, no check is available for comparison, and it is also to be noted that only 13 per cent of the total number of trees were injured in the first place, which is a very much smaller percentage of injury than is common in nurseries in New York. On June 22, other trees of an unknown variety were similarly pruned, except that some of the lower laterals were cut off close to the trunk. In this case only twenty-five trees were treated. By the 15th of August, 88 per cent of the pruned trees had grown up straight." (Crosby and Leonard, 1914:491.)

Back and Price (1912:334) state that this method of pruning is "worthless during the period of greatest activity of *pratensis*, for as fast as a new shoot was formed, the terminal bud was at once killed." Quaintance (1912:108) quotes a letter from a Maryland nursery firm in which the following statement is made:

"The past summer we kept a gang of men going over our peach blocks and cutting or heading-in the side branches in order to throw the growth to the terminals and make them start a second growth. In this way we got our trees to start to grow and the most of them finally outgrew the trouble. We know no other remedy than to cut the side branches back two or three inches."

Because of the favorable results obtained in Maryland and Virginia it was deemed advisable to give this method of pruning the trees a trial. On July 29, injured trees in three rows were treated as follows:

Row a. Forty trees were pruned by cutting off the injured leader down to the first healthy lateral below it. Three or four of the other top laterals were then headed in 5 or 6 inches in order to throw most of the growth into the one chosen to continue the upward growth of the tree.

Row b. Fifty-seven trees in this row were similarly pruned except that about ten of the higher laterals on each tree were headed in.

Row c. Twenty-five trees were pruned in the same manner as were those in row *b* but in addition the lower laterals were cut off entirely to a height of about twenty inches. It is the practice in this nursery to trim off the lower laterals some time in August or later in the season, depending somewhat upon the condition of growth of the trees and the availability of labor. This last method was, therefore, simply the regular fall pruning made at an earlier date.

On November 9 the peach blocks were visited and the pruned trees examined. The results were, on the whole, unsatisfactory. The laterals of all the peach trees in the nursery had made good growth since they were last examined on July 29, due to plentiful rains in August. The weather during June and July had been extremely dry. However, no difference could be noticed between the amount of growth made by the pruned trees in rows *a* and *b* and the unpruned trees about them. In row *c* three or four of the pruned trees had practically outgrown the injury, these, however, constitute only about 12 per cent of the trees treated in this manner.

The early pruning of the lower laterals at such time as most of the tarnished plant-bugs will have left the peach blocks seems to give promise of aiding the trees to outgrow the injury. Much depends, however, on the condition of the weather and the amount of growth the trees make after being pruned. No further conclusions can be drawn as to the exact value of this operation until it has been tried out on a much larger scale.

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NOTE ON THE LIFE HISTORY OF ENCHENOPA BINOTATA SAY (MEMBRACIDÆ) ON THE BUTTERNUT[1]

W. D. Funkhouser

Enchenopa binotata Say occurs in abundance in the vicinity of Ithaca, N. Y., on the butternut, and its life history on this host differs in some interesting respects from that which has usually been described for this insect.

The species is well known and widely distributed throughout eastern United States and its unique form and interesting habits have been productive of numerous references to its appearance. Dr. J. A. Lintner in 1882 described in some detail its habits and particularly its peculiar egg-mass in his First Report[2] and Matausch has given an excellent account of its usual life history with a complete series of drawings showing the froth-covered egg-masses, eggs, consecutive instars of the nymphs and views of the adults in his paper in 1912 in the *Journal* of the New York Society.[3]

The most characteristic feature of the life history of this species of membracid as compared with other Membracidæ is its peculiar habit of covering its eggs with a frothy mass which has often been confused with other insect deposits. The eggs are usually laid in two nearly parallel slits in the bark and the froth is placed over the slits in curious corrugated layers. This has often been observed on bitter-sweet, locust, grape and certain viburnums and on the hop-tree (*Ptelea trifoliata* L.) on which the insect appears to be particularly abundant and which Lintner states is its favorite host. The nymphs are gray-brown, sometimes tinged with greenish, and the adults light ferruginous brown with characteristic yellow bands on the pronotum. The males are usually darker than the females. These habits are to be noted commonly in this locality when the insect chooses for its host the locust (*Robinia pseudacacia* L.) or the bitter-sweet (*Celastrus scandens* L.) on both of which plants it is very common. Locally, however, the species is much more abundant on the butternut (*Juglans cinerea* L.) than on any other host, and it is on this tree that it deviates from its usual habits.

It was first reported as inhabitating the butternut by Fitch in 1851[4] but apparently its life history on this host has not been recorded. Here

[1] Contribution from the Entomological Laboratory of Cornell University.

[2] Lintner, J. A. First Annual Report on the Injurious and other Insects of the State of New York. Albany, 1882, 281–288 p.

[3] Matausch, I. Observations on the Life History of Enchenopa binotata Say. Journ. N. Y. Ent. Soc., March, 1912, Vol. XX: No. 1, p. 58–67, pls. V and VI.

[4] Fitch, Asa. Fourth Annual Report of the Regents of the University of the State of New York on the State Cabinet of Natural History. 1851.

the eggs are laid, not in the bark of the slender twigs, but at the base of the buds and in the buds themselves. In oviposition the female rests on the bud with the head pointed towards the apex and inserts the ovipositor in the base of the bud, usually between two of the lower scales, especially when the winter eggs are being deposited. The ovipositor sometimes enters the twig just below the scales but in almost all cases the insect has some part of its body resting on the bud. Oviposition lasts from ten to twenty minutes after which the insect moves slightly around the twig or to a neighboring bud and repeats the process; three consecutive ovipositions by one female have been noted in the field. This process is most commonly observed during the latter part of August. The egg-slits are rather large, about 1.5 mm. long at the opening and 3 mm. long at the bottom of the slit, and since the buds at the time the eggs are laid, are not usually more than 6–8 mm. in diameter, and the twigs below the buds, which are occasionally infested, about 5–6 mm. in diameter, the egg-mass occupies a considerable part of the host. Two such slits are made, side by side, and about 2 mm. apart. They diverge at the bottom, however, the planes of the slits being at a considerable angle, so that the bottoms of the slits are some distance apart, often at opposite sides of the bud. In each of these punctures from three to six eggs are laid, the usual number apparently being five on each side. The eggs are about 1.5 mm. long and .3 mm. in greatest diameter, often slightly flattened, somewhat curved, more or less flask-shaped and of an opaque white color. The eggs are seldom covered with the frothy deposit so characteristic of this species on other hosts. At first I believed that it was never present, but I have occasionally succeeded in finding it. When present it is not white but a dirty yellow and much thinner and smoother than that which covers the eggs on the locust, on which host I have often seen the insects excrete the substance. I have never found this frothy mass on the buds but only on the twig at the base of the bud. Whether the epidermis of the butternut is or is not conducive to this method of egg protection would be a matter of conjecture.

The nymphs first appear locally about the first week in May. The earliest field record is May 3, 1912. There are five instars, each of which may be recognized by more or less distinct characters of the thorax and abdomen. The nymphs are covered with a white powdery coat which is almost woolly in the younger stages. On the butternut the nymphs retain this white covering throughout the entire five stages and the last nymphal skin is snowy white, particularly on the thorax and on the sides of the abdomen. The opposite is true of the nymphs on other hosts, which, as observed by Matausch (*ibid.*, p. 65), lose this powdery coating after the second molt. The development of the nymphs re-

quires approximately six weeks; a colony which had just emerged on May 10, 1913, was enclosed in netting and of these the first adults appeared on June 21.

The ecdysis consumes from ten to fifteen minutes, the epidermis first splitting on the top of the head, then down the dorsal line of the thorax and finally down the abdomen. The head is first released, appearing rather suddenly, the legs are withdrawn more slowly, and the abdomen gradually worked out of its old skin, leaving a very perfect exuvium. For the last molt the insect moves to the underside of a leaflet and fastens itself securely by the first two pairs of legs. The newly emerged adult is very soft-bodied and almost white, but the normal colors appear in about forty-five minutes.

The adults are first seen in large numbers about the first of July. There is no evidence to show that they winter over in the adult stage. They are usually found grouped about the petioles of the leaves, sometimes on the leaflets, rarely on the twigs and never on the trunk. Unlike most of the local forms of the family, they are often found high up on the trees, although generally preferring the sunny ends of the lower branches. They are very active and fly well, leaving the petiole with a quick "snap" and flying occasionally for several hundred feet. The adults are most numerous in this vicinity in late July and early August and at this time are very abundant. On August 9, 1912, over 200 individuals were collected from one tree in the course of a half hour's collecting and on July 22, 1914, 162 specimens were taken from the lower branches of another tree in a few minutes by three persons collecting. The insects on the butternut are much darker in color than the individuals on other hosts. The males and females are alike in color, both being of a very deep brown, almost black, and both sexes being darker than the males of the species usually appear. So noticeable is this, that when mounted in a cabinet with specimens of the same species collected on other hosts, the difference is at once remarked. It would be interesting to know whether the sap of the butternut on which the insects feed, has anything to do with this variation in color.

It is interesting to note that locally, at least, *Enchenopa binotata* is not attended by ants, and there seems to be no record of such attendence in literature. This is rather remarkable in view of the fact that most of our Membracidæ, particularly in the nymphal stages, are so attended. The nymphs of this species show the same extended anal tube as the nymphs of those species which excrete the fluid which attracts the ants, and they appear in numbers sufficiently large as to be easily discovered by the latter if there was any occasion for this mutual relationship. It should be noted in this connection, however, that

Baer has described[1] a species of the same genus, *Enchenopa ferruginea* Walk., as being attended by ants, and he has observed this species giving off the so-called "honey-dew."

Enchenopa binotata appears commonly in this vicinity on locust, bitter-sweet, wild grape, sycamore, hickory and willow, as well as on the butternut but on none of the former hosts does it show the dark color, the absence of the frothy deposits or the habit of laying eggs in the buds.

This species appears to be of decided economic importance, since it has been reported on a wide variety of host plants and has been known to seriously injure many of them. In the case of the butternut the buds are often entirely destroyed and adventitious growth is found starting from beside the punctured buds which have failed to develop.

I am indebted to Miss Leona Smith for a very fine series of both nymphs and adults of this insect, all collected from the butternut.

EFFECT OF LOW TEMPERATURE ON THE OYSTER-SHELL SCALE

(*Lepidosaphes ulmi* Linn.)

By R. L. Webster

The writer has already noted in general the fact that certain low temperatures of January, 1912, killed the eggs of the oyster-shell scale in many localities in Iowa.[2] Late in 1912, nearly a year after the extreme cold weather, some further data were obtained on the subject. Circular letters requesting samples of the scale were sent out from the office of the State Entomologist to correspondents that had previously sent in specimens. Again in December, 1914, letters requesting additional scale-infested twigs were sent out. All these samples were examined by the writer for sound eggs.

The results in the two years were very different. In the first case, scarcely any scales containing sound eggs were found. In the second, however, most of the samples contained scales with sound eggs. The scale had been practically wiped out in 1912, but in January, 1915, had regained most of the lost ground.

An account of the examination of the samples follows. The notes used are from the files of the entomological section of the Iowa Agricultural Experiment station at Ames.

In order to understand the significance of these observations a brief outline of the life history of the oyster-shell scale is necessary. During

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[1] Baer, G. A. Note sur un Membracide myrmecophile. Ann. Soc. ent. France, 1903, LXXII: Bull. 306.

[2] Journ. Econ. Ent., Vol. 5, p. 470, 1912.

the winter the insect exists in the egg stage, under the scales on the bark of apple and other trees. Near Ames the eggs hatch from about the 10th of May to the 1st of June, depending on the season. The tiny crawling young soon settle down on the bark of the infested tree and proceed to secrete their scaly covering. This is finished in July and late in that month the eggs of the scale insect begin to appear under the mature female scales. There is a single generation, and from the first of August until about the middle of May, a period of nearly ten months, the eggs only are present beneath the scales.

Most of the reports of injury by this insect are from the northern half of the state, as shown in Figure 14. Normally, at least in the last ten years, orchards in this part of the state have been especially susceptible to the scale. Although it occurs in southern Iowa, it is seldom injurious there.

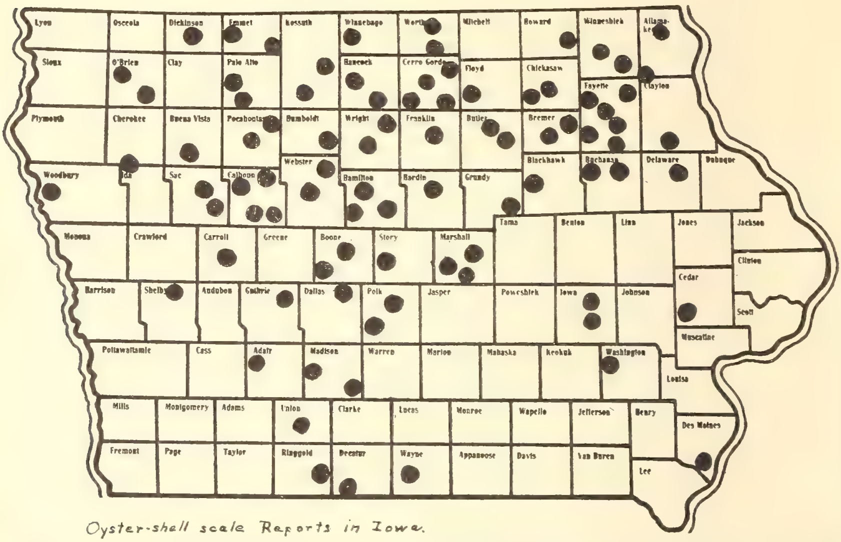


Figure 14.—Localities in Iowa where the oyster-shell scale has been reported as causing damage.

Several hundred scales were examined from each sending, enough to form an accurate idea of the condition of the eggs. As a rule a number of apple twigs were sent, and scales from every twig were examined.

Condition in Winter of 1912–1913

Fifty-four samples of scale were received in response to the first circular letter. These represented 45 localities. Sound eggs were common in only 6 samples. In 6 others there were traces of sound

eggs, but these were so rare that no counts were made. All the remaining samples contained no sound eggs, showing that even at this time, nearly a year after the extreme low temperature, the insect had not begun to regain the lost ground.

Figure 15 shows the condition of the scale in the winter of 1912–1913, together with isotherms of minimum temperatures for January, 1912. All the temperature records are taken from the Iowa Climatological Service of the Weather Bureau, Report for January, 1912.

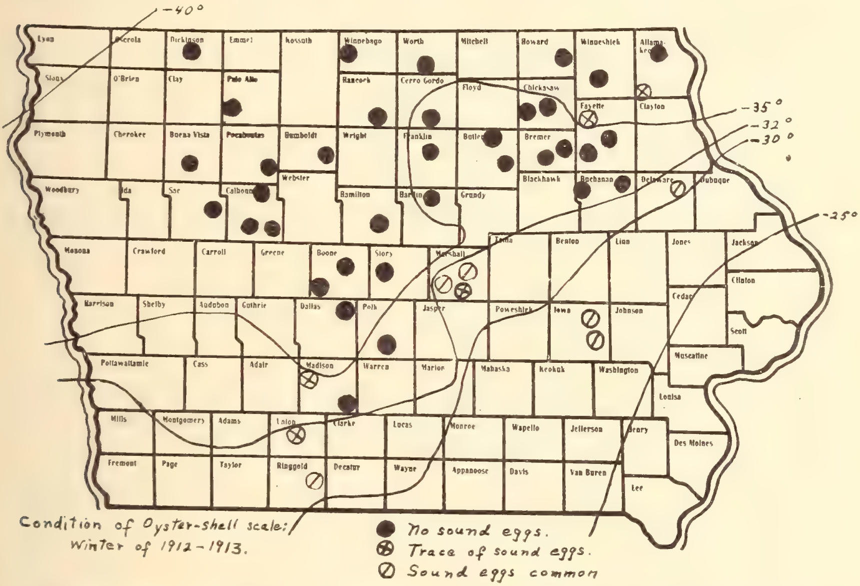


Figure 15—Localities in Iowa where the oyster-shell scale was killed in January, 1912, where it survived, with isotherms of minimum temperatures for January, 1912.

All the localities where no sound eggs were present are included north of the –32° isotherm. That is, a temperature of –32° F. evidently was too cold for the eggs to survive. That they did not survive this temperature is shown by the fact that the scale did not breed in the area north of the –32° isotherm, in the summer of 1912, and so no live eggs were found beneath the scales that fall. Many scales remained on the trees, but there was nothing living beneath them.

On the other hand, in Marshall county, where the minimum temperature was –31°, many scales contained live eggs in the fall of 1912. From the data at hand, it would appear that eggs might safely withstand a temperature of –31°, and yet succumb at –32°. However, since the temperature records and samples of scale frequently were taken in slightly different localities there is some opportunity for

error. Accurate experiments are necessary to establish the precise temperature at which the eggs are killed.

In the previous article I mentioned that a very few young insects hatched out at Ames in the spring of 1912. However, this was observed on a single tree, and on only one branch of that tree, a branch close to the ground on the southeast portion of the tree. Most probably this limb had been protected by snow during the extreme weather, so that it was not subjected to quite so severe cold as the rest of the tree. On the rest of this tree, and on other trees in the orchard, the eggs were all killed.

The fact that empty scales remain on infested trees for several years after the insect has died, and the eggs beneath have hatched out, is misleading to most people. A branch of wood may be literally incrusted with scales, yet an actual examination of these show that very few or none of them contain anything alive. Such was the case in the fall of 1912, when only rarely were scales found that contained anything alive beneath them.

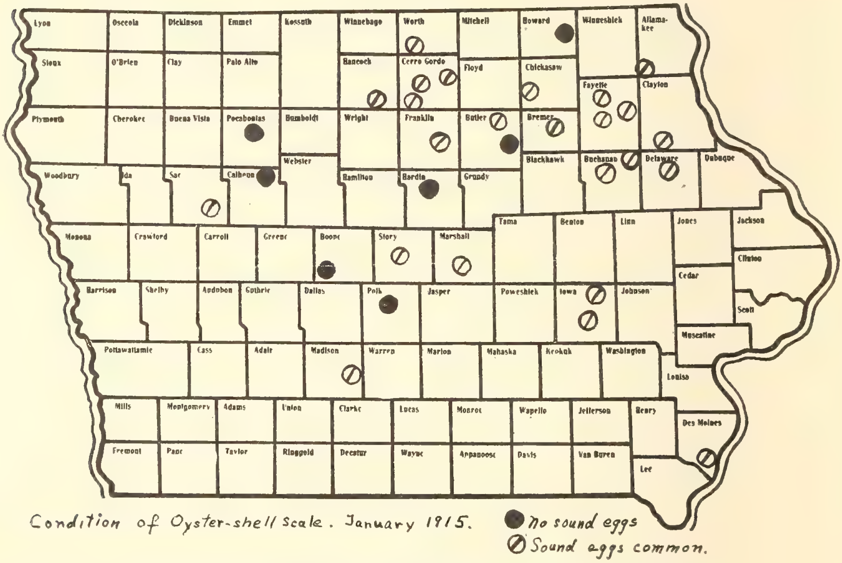


Figure 16—Condition of oyster-shell scale in January, 1915.

Condition in Winter of 1914–1915

Only 3 samples of the scale were received in response to the request of December, 1914. More replies than this were received, but no samples of scale were sent. For instance, in 9 cases the parties addressed could not find samples to send in, though previously they had

sent infested twigs. It appeared that the scale had been checked severely in those localities.

In 7 cases samples sent in contained no sound eggs beneath the scales. Here it was clear that the insect had not recovered from the check received in the winter of 1911–1912, since no indications of life were present 3 years later.

However, in 24 localities, sound eggs were present beneath the scales. This is in striking contrast to the previous report. In certain counties in northern Iowa where the insect had been apparently wiped out, according to scales examined 2 years before, were now (January, 1915) well infested with scales containing sound eggs in abundance. In 2 years the condition had returned, in these localities, to one similar to that immediately previous to the winter of 1911–1912.

CONFUSION OF RHOPALOSIPHUM HIPPOHAES KOCH,[1] AND MYZUS BRAGGII GILLETTE

By C. P. Gillette, *Ft. Collins, Colorado.*

Rhop. hippohœs Koch.

Rhop. hippohœs Koch.—Pflanzenlause, Aphiden, p. 28, 1854.
Phorodon galeopsidis Pass.—Aphidæ Italicæ, 1860.
Phorodon galeopsidis Kalt.—Buckton, Monograph British Aphididæ, V, I, p. 171, 1876.
Rhop. hippohœs Kalt.:—Schouteden, Catalogue des Aphides de Belgique, 1905, p. 235.
Myzus elæagni, del Guercio:—Davis, Annals Ent. Soc. of Am., V, 1, p. 251, 1908.
Phorodon galeopsidis Kalt.:—Davis, Jour. Econ. Ent., p. 325 and 331, 1911.

I believe the preceding bibliography and synonomy and the following brief discussion of the literature upon the above species will help to straighten a rather bad tangle in aphid literature.

Koch took his *Rhopalosiphum hippohœs* from the shrub *Hippohœ*, in the month of June. It happens that this plant serves as the over winter host for both the species under discussion and Koch, both in his descriptions and his figures, gives the alate form of *hippohœs* and the apterous form of *braggii*, or a closely allied species, which is not at all strange, as these two species are remarkably alike in coloration and general appearance.

Kaltenbach took his *Aphis galeopsidis* from species of *Lamium*, *Polygonum* and *Stachys* during September, which are the summer hosts. The apterous lice had capitate hairs and both apterous and

[1] This species probably belongs in the new genus *Capitophorus* Van der Goot. See Zur Systematic der Aphiden, p. 84, 1913.

alate forms had clavate cornicles and a strong tubercle on the inner surface of the second joint of the antenna.

Not having the papers of Walker and Passerini, I shall have to omit their comments, but Buckton has evidently made the same mistake as Koch in confusing the two species except that he has figured what seems to be the apterous form of *hippohœs* and the alate form of *braggii*, and mentions as food plants species of *Galeopsis*, *Lamium*, *Stachys*, and *Polygonum*, and states that the specimens figured were from *Polygonum persicaria* in September.

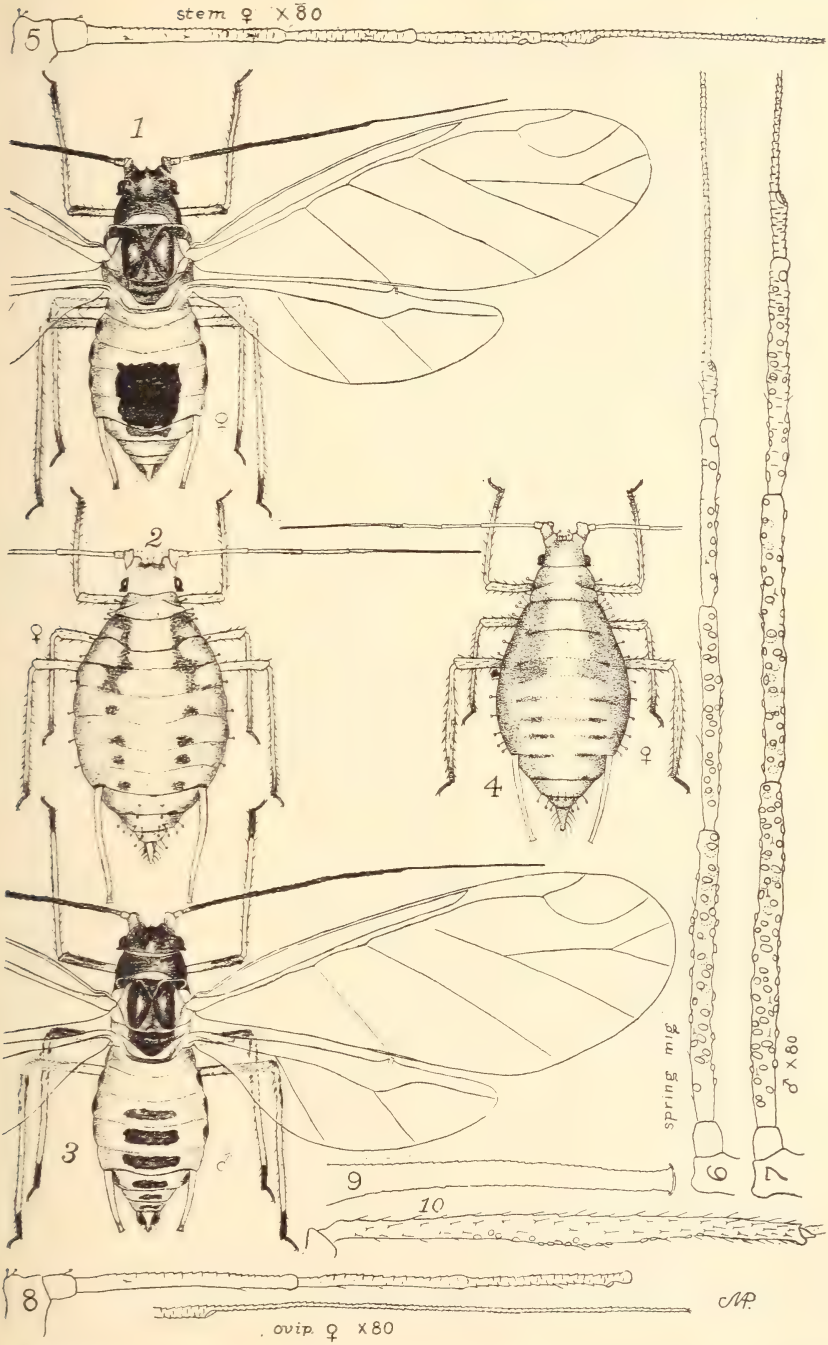
Schouteden evidently had the true sexual forms of *hippohœs*, both of which he described with clavate cornicles, the specimens figured being from *Hippohœs rhamnoides* and *Elæagnus* sp., but he does not mention the date.

Davis, in his paper in *Annals*, 1908, describes and figures the winged and wingless viviparous female, and the oviparous female, and refers to the original descriptions of *Myzus braggii* in *Canadian Entomologist*, January, 1908, for the characterization of the winged male and the winged and wingless viviparous females, but *braggii* always has cylindrical cornicles so that, once more, the two species were confused.

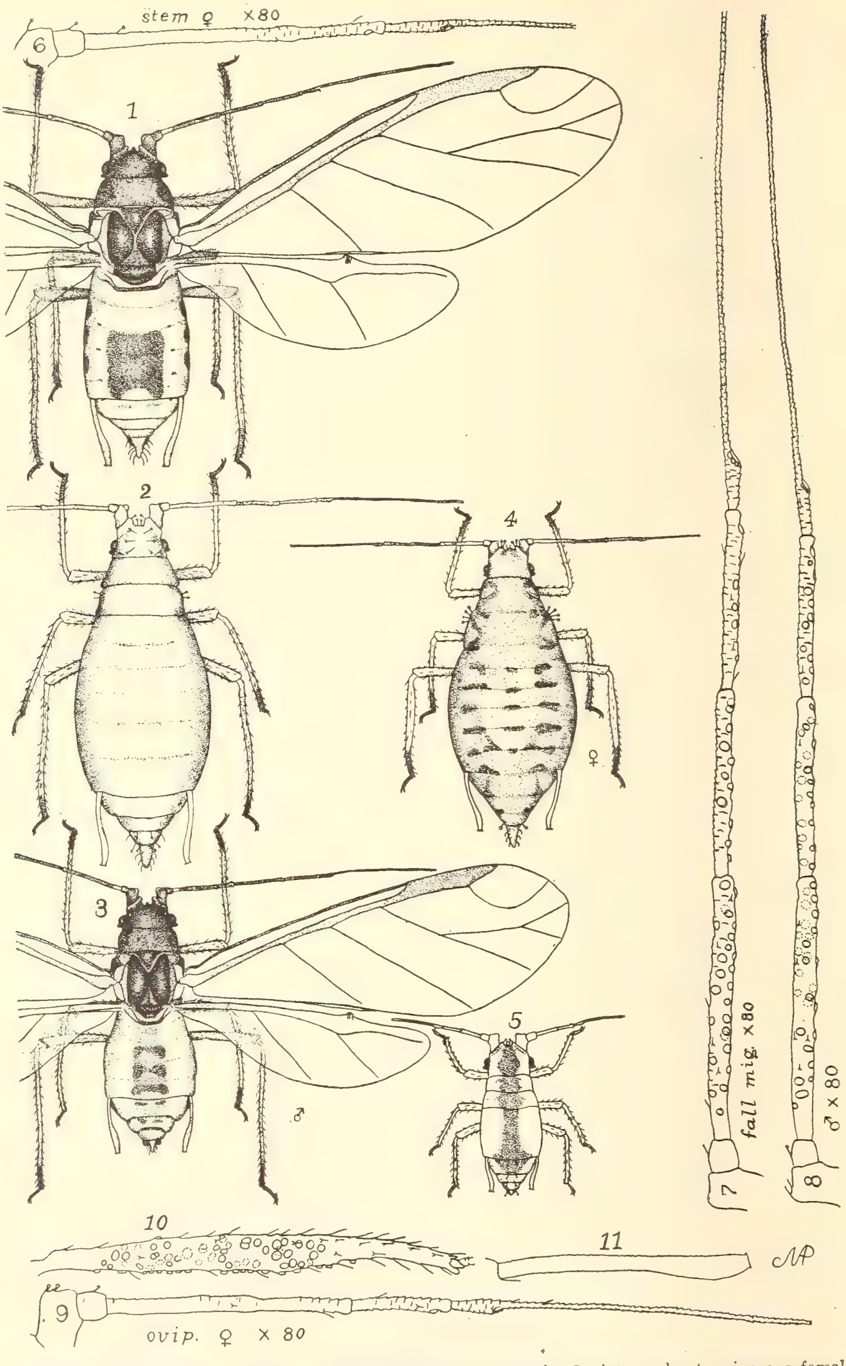
There is no doubt which species Davis had as he describes the clavate cornicles and gives a good figure. Professor Davis also took his specimens on *Elæagnus* in September.

Then, in his paper in Journal of Economic Entomology for 1911, p. 325 and plate 10, Mr. Davis has given descriptions and figures of *hippohœs* which seem to be identical with his descriptions of *elæagni* (*hippohœs*) in *Annals*, mentioned above. It seems that Davis either made a mistake in sending del Guercio a cylindrical, cornicled *braggii* (*hippohœs*) for determination, or else del Guercio made the mistake of overlooking the cylindrical cornicles in the specimens Davis sent. If, on the other hand, the *elæagni* described by del Guercio had clavate cornicles, it seems extremely probable that he was working with *hippohœs*.

At Fort Collins we find *braggii* common and often very abundant upon the Canada thistle (*Cirsium arvensœ*) during the latter part of summer and early fall every year, and it also occurs on artichoke, *Cynara*, *Scolymus;* the winter hosts are the Russian olive, *Hippohœs rhamnoides* and *Shepherdia arvensis*. *Rhop. hippohœs* we take upon *Polygonum* during the summer and upon Russian olive and *H. rhamnoides* during the fall, winter and spring. We have never found the form with clavate cornicles upon the Canada thistle; neither have we found the form with the cylindrical cornicles upon *Polygonum*, or *Persicaria*, but both forms occur upon the Russian olive (*Elæagnus*) and *Hippohœs*.



Myzus braggii, Gillette: 1. alate viviparous female; 2. apterous viviparous female; 3. alate male; 4. oviparous female; 5. antenna of stem female; 6. antenna of spring migrant; 7. antenna of male; 8. antenna of oviparous female; 9. cornicle of oviparous female; 10. hind tibia of oviparous female.
Figures 1-4 enlarged 20 diameters; all others 80 diameters.



Rhopalosiphum hippohæs: 1. alate: 2. apterous viviparous female; 3. alate male; 4. oviparous female; 5. young male; 6. antenna of stem female; 7. fall migrant; 8. apterous female; 9. oviparous female; 10. hind tibia of oviparous female; 11. cornicle of oviparous female. Lice all enlarged 20 diameters, and all other figures 80 diameters.

Drawings by Miss M. A. Palmer.

During the fall of 1913, *hippohœs* was traced from *Persicaria* to *Elæagnus* and *Hippohœs*, where the oviparous females were deposited, the winged males coming later. In the spring of 1914, branches of *Elæagnus* and *Hippohœs rhamnoides* having eggs of *Rhop. hippohœs* and *Myzus braggii* were taken to the insectary where they hatched and the second brood developed wings in both species. *Rhop. hippohœs* was placed upon *Persicaria* where the alate specimens immediately gave birth to young which remained on the plant. These passed through ten generations on this plant. *Myzus braggii* was placed upon the Canada thistle and was reared with equal success.

The figures on Plates I, and II, will indicate how distinct these two species are.

Another species of Rhopalosiphum, closely allied to *hippohœs* but more robust, with capitate hairs upon the dorsum of both the apterous and alate forms and with filament of antenna much shorter than in *hippohœs*, has been taken repeatedly upon *Elæagnus* and *Hippohœs* but the summer host has not been found. It is very well represented by Koch's Figure 37, except that the cornicles are clavate near the end as in *hippohœs*.

A DESTRUCTIVE PINE SAWFLY INTRODUCED FROM EUROPE.

Diprion (*Lophyrus*) *simile* Hartig

By W. E. Britton, *State Entomologist,*
New Haven, Conn.

On August 27, 1914, in company with my assistants, Messrs. I. W. Davis and M. P. Zappe, while inspecting a nursery in New Haven, a few scattered sawfly larvæ were noticed feeding upon the foliage of pine trees six to eight feet tall. This work was continued for the next few days and, in one part of the nursery, where several species of pines were planted for exhibition and sale, the larvæ were rather abundant, and the men spent an hour or more gathering all that could be found and the material was taken to the laboratory.

Supposing it to be a native and not uncommon species, and knowing that Dr. A. D. MacGillivray, who has prepared the portion concerning sawflies for the forthcoming Hymenoptera of Connecticut, was studying sawfly larvæ, some of this material was sent to him and the remainder placed in breeding cages in our insectary. Dr. MacGillivray did not recognize the species from the larvæ but thought that he might identify it if the adult stage could be obtained. On April 8, 1915, a male emerged from a cocoon in one of the cages, followed by others, and on April 15 a female appeared. Some of the males and females

were transferred to cages containing small potted white pine plants and eggs were soon obtained.

On April 21, I wrote about this to Dr. MacGillivray, who at once examined his cages and found some adults. He stated that he did not know the species but that it belonged to the genus *Diprion* formerly known as *Lophyrus*. The species are badly confused and he recommended that we send material to Mr. S. A. Rohwer, of Washington, D. C., who is at work on the group and has examined many of the types in the British Museum. Consequently some adults of both sexes, an inflated larva and a pupa case were submitted on May 6, to Mr. Rohwer who wrote as follows:

"I have determined this species, tentatively, as *Diprion simile* Hartig. The adults agree more closely with those in the collection under the name *pini* but the larvæ answer exactly the description of *simile*, and as these two species are very closely allied and easily confused in the adults I have made the determination from the larvæ rather than from the adults.

"This species is one of the most injurious sawflies on European conifers and has been associated in practically all of the depredations caused by *pini*, and is recorded in the literature in a number of cases under the name of *pini*. You are no doubt familiar with the economic importance of *Diprion pini* in Europe. It is highly important that immediate measures be taken to combat this injurious insect as it has a large number of host trees and would no doubt adapt itself readily to the conditions in America, where, if it were thoroughly established without its parasites, it would do a great deal of damage."

The appearance of this insect in all its stages is shown on plate 19 and briefly may be described as follows:

Egg.—The eggs are laid end to end in slits made along one of the ridges at the edge of the needle. The eggs are pale blue in color, smooth and slightly shining. The sides are parallel with the ends rounded. Length, 1.25 mm., thickness, .33 mm. In the material examined the newly laid eggs were slightly separated in the slits. The eggs before hatching increase in size, becoming crowded in the slits so that the ends are flattened like peas in a pod.

Larva.—Length, 25 mm. (1 inch) to 28 mm. ($1^1/_8$ inches). Thickness, 4 mm. ($^5/_{32}$ inch). Head black, body greenish yellow with a mid-dorsal double stripe of brown extending the entire length. On either side of the dorsal stripe is a yellow stripe broken with transverse markings of brown. The remainder of sides dark brown with many irregular yellow or whitish spots. Ventral surface pale yellow or white. Pro-legs yellow with a transverse black mark at base, true legs marked with black and yellow.

Cocoon.—9 mm. long (about $^3/_8$ inch), thickness about 5 mm., oval in shape, tough leathery and fairly smooth. Color, sepia.

Male.—Wing-spread, 14 mm. ($^9/_{16}$ inch). Length, 7 mm. Large pectinate antennæ. Head and pronotum coarsely punctured. Head, antennæ and body,

black. Cerci and tip of the last abdominal segment, orange. Legs yellow, with the trochanters and basal two-thirds of the femora, brownish black.

FEMALE.—Wing-spread, 20 mm. (little over $^3/_4$ inch). Length, 8 mm. ($^5/_{16}$ inch). Robust, head and antennæ black. Thorax coarsely punctured, yellow with a large shield-shaped black spot on mesothorax, extending from the anterior margin and covering about two-thirds of the space between the parapsidal grooves. On either side are a pair of L-shaped black marks which approach each other posteriorly. Posterior margin of the mesothorax, postscutellum and prosternum, black. Abdomen yellow with dorsal surface of 3d, 4th, 5th, 6th, and the anterior portion of 7th segment, black. Legs yellow with the outer surface of hind femora, the apex of the middle and hind tarsi, dark.

Lophyrus similis Hartig is mentioned by Kaltenbach[1] as occurring with *L. pini*, the larvæ appearing in June and the adults from July to September. Judeich-Nitsche[2] also include this species with *L. pini*, *L. rufus* and *L. pallidus* and state that the full-grown larvæ will each devour from six to twelve needles per day, preferring the old needles.

More recently, however, Dr. L. Reh[3] places *simile* as a synonym of *pini*, and states that it is one of the most important species of the genus, feeding upon all kinds of conifers and having two generations each year. The young larvæ feed upon the edges of the needles leaving only the midrib but later they devour the entire needles. The summer brood makes cocoons on the branches of the tree, and the fall generation makes cocoons on the rubbish underneath it.

For several years *Lophyrus pini* has seriously damaged the pine forests of Southwestern Russia,[4] especially the young trees. This species was particularly destructive in France[5] in 1906, and it has also done damage in Prussia and in Sweden. In England it is said to injure Scotch Fir[6] as well as pine.[7]

In the Connecticut nursery the larvæ were found feeding upon the white pine, *Pinus strobus;* the Austrian pine, *P. laricio* var. *austriaca, P. flexilis* and *P. densiflora*. These trees were sprayed with lead arsenate in September.

In Europe raking up and destroying the leaves and other rubbish under the trees in fall is recommended to destroy the cocoons.

Spraying the foliage with arsenate of lead will also prove effective.

It is hoped that entomologists will be on the watch for this insect

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[1] Die Pflanzenfeinde, p. 700, 1874.

[2] Forstinsektenkunde, p. 635, 1895.

[3] Handbuch der Pflanzenkrankheiten, Die Tierischen Feinde, Dritter Band, p. 598, 1913.

[4] Review of Applied Entomology, Vol. I, pp. 395 and 493, 1913.

[5] A. Barbey, Traité D'Entomologie Forestière, p. 269, 1913.

[6] W. E. Collinge, A Manual of Injurious Insects, p. 217, 1912.

[7] E. A. Ormerod, Manual of Injurious Insects and Methods of Prevention, p. 250, 1890.

which has been imported into the United States and apparently become established here. Its method of introduction is, of course, unknown but it is probable that a few cocoons on the branches or in the packing material of pines from Europe were overlooked by the inspector.

Mr. Rohwer has kindly furnished the following references, which apply only to *D. simile:*

Hartig, T.—1834. Forstliches Convers.—Lexicon 2. Aufl. p. 987. (Original account.)

Hartig, T.—1860. Die Familien der Blattwespen und Holzwespen, p. 160, pl. III, fig. 9 (Original description and a short account of life history and presence around Berlin and Stettin.)

Baer, W. —1903. *Lophyrus similis* Hart.—Naturwissenschaftliche Zeitschrift für Land- und Forstwissenschaft. vol. 4, H. 2, p. 84–92, 10 fig. (Contains many notes but publication is not at present minute available, so cannot be summarized.)

Forsius, R.—1911. Medd. Soc. Fauna Flora Fennica, vol. 13, p. 183. (Presence in Finland in 1910.)

Reviews.

Key to the Families of North American Insects, an Introduction to the Classification of Insects, by Charles T. Brues and A. L. Melander. Published by the Authors, Boston, Mass., and Pullman, Wash., 1915, pp. i–viii, 1–140.

The past twenty years have witnessed a wide departure from the primary seven principal orders of the early entomologists, a process which has advanced by gradual stages and appears to have reached its climax in this tabulation. Most entomologists recognize the necessity of more exactly defining the larger groups and though by no means all will agree with the system adopted in this work, they must admit that it presents within a very brief compass, considering the complexities of the subject, an excellent analytical key. A most praiseworthy feature, not always seen in technical works, is the evident attempt to correlate the system with earlier ones and particularly to establish a definite relation with economic forms. There are, in addition to the keys, a conspectus of the higher groups of insects, five classes being recognized, brief statements of the ordinal characters, a series of 18 line plates illustrating typical forms or structures, a glossary and indices of both scientific and common names. This laboratory manual will be exceedingly helpful to all entomologists and we hope it may prove a potent factor in establishing a more satisfactory arrangement of the larger groups of insects.

Erratum. Page 269, line 2 for *Carpophilus latinasus* read *Caulophilus latinasus.*

Diprion simile: Hartig. 1. Adults, twice natural size; 2. Eggs in pine needle, about 4 times enlarged; 3. Cocoons, natural size; 4. Larvæ feeding on pine, natural size.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

JUNE, 1915

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, as far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engravings may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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The summer meeting in California deserves the hearty support of every active entomologist. It will afford one of the best opportunities of getting into closer touch with a large body of aggressive investigators, who, partly on account of the peculiarities of their problems and also because of distance, are somewhat separated from the eastern students, though we are all in a land where there is no East or West, no North or South, scientifically speaking. The western men are of themselves capable of making this gathering a notable one in the annals of science. The eastern students of insect life have a duty, though extremely pleasant, in relation to this meeting. It is earnestly hoped that all sections of the country may be adequately represented at the coming meeting.

Substantial progress, it will be noted by referring to the Current Notes, has been made in the preparation of the Index of Economic Entomology, the continuation of the well known and frequently used Bibliography of American Economic Entomology in what is hoped will prove a more useful and convenient form. Publications of this kind are frequently consulted with little thought of the labor, often thankless, involved in their preparation. The work now being compiled covers a decade and is going to prove immensely helpful to every progressive worker. The compiler should have every possible assistance and it is very probable that a few words of appreciation for the man who has the patience to carry such a work through to completion would not come amiss. There must be many entomologists who have a personal as well as a professional interest in the publication of any such compilation.

Current Notes

Conducted By The Associate Editor

W. V. King, Bureau of Entomology, received the degree of doctor of philosophy from Tulane University, in January.

Mr. Frank R. Cole has been appointed scientific assistant, Bureau of Entomology, to work temporarily at Pasadena, Cal., and vicinity.

Mr. Thomas H. Jones of the Bureau of Entomology is stationed at Baton Rouge, La., and is investigating truck crop insects.

Mr. R. J. Fiske, Bureau of Entomology, is now stationed at Roswell, N. H., where he is engaged on codling moth investigations.

Mr. H. P. Wood, Bureau of Entomology, now located at Dallas, Texas, was married to Miss Ester Danielson of Hopedale, Mass., April 3.

The Department of Entomology of the Texas Agricultural College, has just completed a greenhouse, for use as an insectary, at a cost of $1,200.

Mr. C. E. Smith has been engaged by the Bureau of Entomology to assist Mr. Thomas H. Jones in work on truck crop insects at Baton Rouge, La., and vicinity.

Mr. E. R. Speyer has taken up a temporary appointment under the Ceylon government for the purpose of investigating the shothole borer of tea (*Xyleborus fornicatus*).

Mr. Richard Lydekker, F. R. S., the well-known English zoologist, died April 16, aged 65 years.

J. L. Webb, Bureau of Entomology, left Washington on April 25th for Tallulah, La., where he will be attached to the boll-weevil laboratory.

Mr. F. W. Dry, a Carnegie scholar, is on a trip with Professor Webster, visiting the eastern field stations of the section of Cereal and Forage Crop insects.

According to *Science*, Professor M. A. Lameere, University of Brussells, has been nominated as an honorary member of the Societé Entomologique de France, in place of the late M. J. Perez.

T. C. Barber, recently of the experiment station at Tucuman, Argentina, has been engaged as an agent of the Bureau of Entomology, and is attached to the Tallulah laboratory.

Mr. R. S. Clifton, executive assistant of the Bureau of Entomology, is now stationed at the headquarters of the gypsy and brown-tail moth investigations, 43 Tremont St., Boston, Mass.

Dr. Henry H. P. Severin has again accepted a temporary position for the summer at the Maine Agricultural Experiment Station to test the poisoned bait spray to control the currant or gooseberry fruit-fly and the apple maggot.

Messrs. R. W. Wells, M. J. Stanley, and G. H. Cowan have been appointed to service in the Bureau of Entomology, in connection with the spotted-fever tick work in Montana.

Governor Ferguson of Texas, on March 22, approved an emergency appropriation of $3,000 for eradication of foul brood in that state. The work will be in charge of State Entomologist Wilmon Newell.

Mr. Arthur J. Ackerman, Bureau of Entomology, spent the winter in Washington, and in March started on a short trip through the southern states investigating nursery insects. As last year, he is located at West Chester, Pa.

A. H. Jennings, Bureau of Entomology, who has been engaged for some time in the study of the possible transmission of pellagra by insects, will be detailed to the investigation of malarial mosquitoes. He is now located at Mound, La.

B. R. Coad, Bureau of Entomology, has been placed in charge of the boll-weevil laboratory at Tallulah, La. G. D. Smith, formerly of this station, has been located at Thomasville, Ga., where he will conduct studies of a number of cotton pests.

Mr. W. F. Fiske is now engaged in an investigation of the tsetse flies (*Glossina* spp.) for the Tropical Disease Commission and is stationed in the vicinity of Lake Victoria Nyanza, where he plans to remain for the next fourteen months.

Second Lieutenant Duncan H. Gotch, Worcestershire Regiment, entomological assistant in the Imperial Bureau of Entomology, was killed in action at Neuve Chapelle on March 11.

Professor C. L. Metcalf of Ohio State University will spend the summer months, beginning June 15, at the Agricultural Experiment Station, Orono, Maine. He will be engaged in a systematic and economic study of the Syrphidæ.

Mr. E. P. Taylor has resigned as field horticulturist, Extension Department of the University of Idaho, Boise, Idaho, and accepted the position of horticulturist, Utah Fruit Growers Association, Box 1878, Salt Lake City, Utah.

G. A. Runner, Bureau of Entomology, spent several days during April in the laboratories of the General Electric Co., Schenectady, N. Y., conducting experiments in the destruction of the cigarette beetle (*Chalcodermus æneus*).

Mr. Carlton C. Gowdy, government entomologist in British East Africa, was given a ten months' leave of absence and spent the winter months in advanced work in entomology at the Massachusetts Agricultural College, of which he is a graduate in the class of 1908.

Mr. Neale F. Howard, a graduate of the Agricultural College, University of Wisconsin, will work with the Bureau of Entomology on the pea aphis, root maggots, and other insects affecting truck crops, with headquarters at Green Bay, Wis., in cooperation with the University of Wisconsin.

U. C. Loftin, Bureau of Entomology, is now in Cuba where he will be engaged for several months in the study and collection of parasites of sugar-cane insects and the investigation of the relation between certain systems of culture and the sugar-cane borer.

Entomological News records the death of the following European entomologists: Ferdinand Kowarz, the well-known dipterist at Franzensbad, Bohemia, September 14, 1914; Dr. F. Trybom, of Sweden, February 15, 1915; Doctors Walter Stendell, Otto Kirchhoffer, W. Haas and F. Vogel who have been killed in the war.

Mr. O. K. Courtney, a graduate of the Texas Agricultural and Mechanical College, has been appointed to the position of assistant entomologist in the Department of

Entomology at that institution, succeeding Mr. Walter W. Marshall who has taken up graduate work at the Ohio State University.

The General Assembly of Connecticut adjourned on May 18, after appropriating $25,000 for the next two years for suppressing the gypsy and brown-tail moths. Of this amount $4,000 is immediately available for summer work. Twenty towns are now known to be infested with the gypsy moth and 72 with the brown-tail moth.

August Busck, Bureau of Entomology, left Washington early in May to spend six months in the Hawaiian Islands in the study of *Gelechia gossypiella*. Special information regarding the habits of this species are required in connection with the proposed action to prevent the establishment of the species in the United States.

Professor Henry E. Van Deman, first professor of horticulture in Kansas State University, and first head of the Division of Pomology, United States Department of Agriculture, died at his home in Washington, D. C., April 28. Since 1893 Professor Van Deman has been engaged in work of an editorial and advisory nature.

According to *Science*, Dr. Raymond C. Osburn, assistant professor of zoölogy in Barnard College of Columbia University, has resigned to accept the professorship of biology in the new Connecticut College for women at New London. It is understood that the college will be ready for work at the beginning of the next college year.

The following have been elected to the fellowships in entomology at the University of Illinois: Alvah Peterson, Knox College; Philip Garman, Kentucky Agricultural College. The following have been elected to scholarships; Edwin K. Parker, Massachusetts Agricultural College; L. B. Ripley, Trinity College, and J. L. King, Ohio State University.

The field laboratory of the Bureau of Entomology in Maine has been discontinued. Mr. F. L. Simanton, formerly in charge, has been transferred to the laboratory at Benton Harbor, Mich., where he will undertake investigations in connection with orchard insecticides and spraying machinery. He will be assisted by Mr. H. G. Ingerson.

Mr. W. M. Davidson, Bureau of Entomology, has returned to his headquarters, Walnut Creek, Cal., where he will continue his investigations in connection with the grape Phylloxera. During his stay in Washington the report on the biology of this insect was about completed, and another season's observations will complete the subject in a satisfactory manner.

Mr. Irving R. Crawford has been appointed temporary field assistant, Bureau of Entomology, and will proceed to San Diego, Cal., to collect parasites of *Hemileuca oliviæ* in northeastern New Mexico. The force engaged upon this investigation will consist of Mr. D. J. Caffrey, in charge; Messrs. Crawford and J. R. Sandige, temporary assistants; and a permanent appointee not yet selected.

F. C. Bishopp, Bureau of Entomology, Box 208, Dallas, Texas, has undertaken the taxonomic study of fleas. He has probably one of the largest collections in the United States at the Dallas laboratory but desires to obtain additional specimens from all parts of the country. It will assist greatly in his studies if material of this kind is sent directly to him.

Mr. P. H. Timberlake, Bureau of Entomology, who has been spending the winter at the Brownsville, Tex., laboratory, engaged particularly on the hymenopterous parasites of lady beetles, will return to Salt Lake about the middle of April, and on his

return Mr. L. P. Rockwood will be transferred temporarily to Forest Grove, Ore., to assist in the clover-insect investigations being carried on at and from that laboratory.

A card index to all illustrations used in the Bureau of Entomology and the former Division of Entomology, is maintained by the Bureau at Washington. It also includes the reports of the U. S. Entomological Commission and the later entomological papers of the U. S. Department of Agriculture. A general card index of all entomological publications issued by the U. S. Department of Agriculture is now being prepared.

A new project relating to the control of the house-fly and other insects in establishments operating under the meat inspection act has been approved by the Secretary. This is a joint investigation between the Bureau of Entomology and the Bureau of Animal Industry. The headquarters for the work will be at the Dallas laboratory and F. C. Bishopp will be in direct charge. A conference was held at Washington early in May at which the detailed plans for the investigation were discussed.

Mr. Carrington B. Williams, Carnegie scholar, took a trip to the West Indies in March and returned to Washington about April 8, with a very large collection of Thysanoptera made on the trip. On his return he worked night and day with Mr. J. D. Hood, of the U. S. Biological Survey, describing the new species for a joint paper soon to be published. He visited Barbados, Trinidad, and Porto Rico and saw some tropical economic entomology. He sailed for England on April 17.

Mr. E. H. Siegler, Bureau of Entomology, formerly in charge of the laboratory at Benton Harbor, Mich., in connection with the project of insecticide investigations, has been placed in immediate charge of the laboratory at Grand Junction, Colo., where, in coöperation with the Colorado Agricultural Experiment Station, he will undertake a thoroughgoing investigation of the codling moth in the Grand Valley. He will be assisted by Mr. E. R. Van Leeuwen.

A hearing before the Federal Horticultural Board was held in Washington, D. C., on May 6, in regard to extending the quarantine lines to include additional territory now infested by the gypsy and brown-tail moths. Messrs. A. F. Burgess, L. H. Worthley and D. M. Rogers of the Bureau of Entomology located at Boston, Mass., Professor W. C. O'Kane of New Hampshire, Irving W. Davis of Connecticut and Harry B. Weiss of New Jersey were among those in attendance.

The index of economic entomology, covering the literature since 1905, is now fairly under way. Two typists are engaged in assisting Mr. Nathan Banks in the preparation of the manuscript, and a third will soon be employed. More than one-half of the experiment station literature has been indexed, and work on the publications of the Bureau of Entomology is nearing completion. It is estimated that there will be at least 25,000 entries.

W. D. Hunter and G. B. Sudworth, of the Federal Horticultural Board, had a conference at Pittsburgh, Pa., on April 14, with the designers of a machine which may be adapted for the fumigation of bales of cotton. On April 20, a conference was held with the department regarding the proposed action of the Federal Horticultural Board, regarding the fumigation of all foreign cotton received in this country to destroy the immature stages of *Gelechia gossypiella*. Representatives of cotton mills from all parts of the country were present.

In conjunction with the Southern Conference for Education and Industry, held at Chattanooga, Tenn., April 27–30, there was a conference of southern beekeepers. The meeting on the first day was devoted to a discussion of beekeeping for teachers and others interested in the development of beekeeping in the South. The Tennessee State Beekeepers' Association called a special meeting in connection with this con-

ference on April 28-29. Dr. E. F. Phillips was chairman of the beekeepers' conference.

Mr. E. R. Sasscer, chief inspector of the Federal Horticultural Board, reports as a result of his inspection of the Introduction Garden at Miami, Fla., the finding of a new and dangerous scale insect infesting mangoes, namely, *Lecanium* (*Coccus*) *mangiferæ*. Incidentally he saw something of Mr. Yothers' work in Florida and reports as an eye witness some remarkable demonstration results from spraying, in which the fruit output was enormously increased and the quality much improved as a result of the treatment.

A considerable collection of books and magazines has been amassed by the State Entomologist and Director of the Illinois State Laboratory of Natural History, Professor Stephen A. Forbes, by purchase and exchange during the past twenty or more years. This collection has been supplemented in recent years by extensive purchases by the Library of the University of Illinois. There has been spent during the past biennium alone over three thousand dollars in the purchase of books on entomology and nearly six thousand dollars for zoological publications, many of which contain articles of great interest to the entomologist.

Messrs. H. G. Champion, of the University of Oxford and the Indian Imperial Forest Service, and T. E. Snyder of the Bureau of Entomology, spent some ten days during January touring lumber mills in the high mountains of West Virginia in the study of the industry and the insects involved. While visiting the Union tannery at Davis, W. Va., they were informed by the manager that, following recommendations to prevent injury by the tanbark borer (*Dinoderus substriatus* Payk.), they used all hemlock tanbark before it was four years old. Dr. A. D. Hopkins visited this tannery in 1901 and found that out of a total of 20,000 cords of bark about 10,000 were badly damaged by this beetle. On close investigation he found the damage was practically confined to bark that was from two to seven years old, and no appreciable damage was done in bark less than three years old. Accordingly, he recommended that, in order to avoid this loss, older bark be used first, and that no bark be kept for a longer period than three years. Thus, by following the suggestion then made, enormous loss has been prevented in this tannery alone.

The Mediterranean fruit-fly force at Honolulu now includes, in addition to the leaders, Dr. Back and Mr. Pemberton, also Messrs. Willard, Banks, and Maxwell, Ah Fook, a Chinaman, and Muto, the Jap. Aside from Muto, these men are all connected with the inspection service. The present arrangement puts Mr. Willard in general charge of this service under Dr. Back. Mr. Willard is a graduate of the Massachusetts Agricultural College, who came to the islands as instructor in agriculture and farm superintendent at the Mills Institute, Honolulu, and is reported by Dr. Back as being a very useful and serviceable assistant. Dr. Back, with Mr. Pemberton, will be engaged during the next three months in an investigation of the fruit-fly as affecting coffee, and other coffee insects of the Cona district, Island of Hawaii. This is the great coffee district of Hawaii. The pulp of the coffee berry is a favorite food of the Mediterranean fruit-fly and frequently as many as a dozen maggots of this fly can be taken from a single coffee berry which is no larger than a medium-sized cherry. Of vast interest to the coffee industry and to the fruit-fly control on the island is the fact reported by Dr. Back, that one of the parasites recently introduced on the island through the agency of the Territorial board of agriculture is already parasitizing the maggots in coffee berries to an average of upward of 50 per cent, in some instances reaching as high a percentage as 96. The parasite in question is *Opius humilis*. This seems to be another one of the many successful parasite introductions which have been carried out on these islands.

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NOTES ON THREE SPECIES OF HELIOPHILA WHICH INJURE CEREAL AND FORAGE CROPS AT BROWNSVILLE, TEXAS

By R. A. Vickery, *Entomological Assistant, Cereal and Forage Insect Investigations, Bureau of Entomology, U. S. Department of Agriculture*

The larvæ of *Heliophila subpunctata* Haw., *H. unipuncta* Haw., and *H. multilinea* Walk., have all been found injuring cereal and forage crops in southern Texas. *Heliophila subpunctata* is found on corn, sorghum, sugar-cane, barley, oats and Bermuda grass, but prefers sorghum and sugar-cane. *Heliophila unipuncta* is found on the same plants as *H. subpunctata* and also on alfalfa but prefers low-growing plants such as alfalfa, barley and oats. *Heliophila multilinea* has the same habits as *H. subpunctata* and has been found so far on sorghum and sugar-cane. The larva of this species looks like that of *H. subpunctata* and we have not been able to separate them; but only a few of this species have been found.

These species are found in large numbers from November until March and are rare in the summer. *H. unipuncta* has not been found in the summer.

The jaws of these larvæ are not toothed but are smooth and come together like the edges of a "cutting pincer" and cut in the same manner as the pincer cuts. The jaws have this shape in all stages of the larva and for this reason the larvæ feed at the edge of the leaf in all stages. In the first two stages they are not able to bite through a leaf but they begin work on the edge. In feeding they straddle the edge and seizing the leaf in their jaws bite a piece out of it and usually continue feeding until a large notch is eaten out.

This manner of feeding compels the larvae to expose themselves in order to feed. This is probably why they feed only at night and hide during the day. It is possible that this habit exposes them only to the attacks of nocturnal parasites as they are so well hidden during the day that it would seem to be almost impossible for the parasites

to find them. As they have the same habits as the cutworms they should have about the same parasites.

Because of the necessity of hiding themselves during the daytime, the larvæ prefer rank-growing crops like broadcast sorghum, sugar-cane, and small grain or hay crops. In these crops they can hide themselves in the dead leaves on the ground.

The moths usually lay their eggs between two dead, dry leaves, the eggs being cemented to the leaves. They are apparently well protected from the attacks of parasites. These facts are based on laboratory observations as we have not found the eggs outdoors.

In rearing the insects in the laboratory the moths are placed in large No. 2 street-lamp globes and are fed on sugar syrup. Folded strips of wrapping paper are placed in the cages for them to lay their eggs on. They lay their eggs freely on this paper and it is easy to handle and always obtainable.

Larvæ are kept in 1-ounce seamless tin boxes, one larva in each box, and are fed on corn leaves if available, otherwise they may be fed on sorghum, oat or barley leaves. Larvæ in the first three stages may be kept in 2-, 3-, or 4-ounce tin boxes, many larvæ in each box.

The species all appear to be of tropical or of subtropical origin, and were probably native on rank-growing grasses in lowlands. They spend the winter in all four stages, but as all stages are unprotected against extremes of temperature, it would seem that they cannot winter very far north. It is probable that they usually do not winter very far from the Gulf of Mexico, but in the Mississippi Valley *H. unipuncta* might winter as far north as Tallulah, La., and on the Atlantic coast it might go through a mild winter as far north as the city of Washington. A discussion of the question as to which stage is best able to withstand cold weather is useless speculation as these facts can easily be learned by a series of experiments with low temperature incubators. If it should happen at any time that the conditions in the country near the Gulf of Mexico are especially unfavorable for the parasites, the moths would occur in large numbers and migrate northward. In a northern locality the worms would be free from their ordinary parasites and would find plenty of food in the grain fields. The young larvæ, not being controlled by their parasites, could mature in such large numbers that they would be compelled to migrate in search of food. But this migration would attract predaceous mammals, birds, and insects, and also native parasitic insects normally infesting other lepidopterous larvæ. This appears to be what actually occurs in the case of *H. unipuncta* and outbreaks in the north are abnormal, since the larvæ are killed by the cold weather and for this reason do not appear the following year. *Heliophila subpunctata* will perhaps

be limited to the far south because of its preference for sorghum hay and sugar-cane. Corn, and sorghum grown for syrup, are cultivated and do not afford shelter for the larvæ.

These larvæ are controlled by the following parasites: From small larvæ, *Meteorus laphygmæ* Vier., *Apanteles harnedi* Vier., and *Microplitis* sp.; from large larvæ, *Enicospilus purgatus* Say, *Rhogas atricornis* Cress., *Peleteria robusta* Wied., *Apanteles militaris* Walsh, *Apanteles rufocoxalis*, *Paniscus* sp., *Euplectrus platypypenæ* v. d. Wulp.; from the pupæ, *Ichneumon* sp. *Archytas analis* Fabr., and *Archytas piliventris* How.

We encounter then in connection with these species 13 primary parasites, only 4 of which (*Meteorus laphygmæ*, *Apanteles harnedi*, *Euplectrus platypypenæ*, and *Archytas piliventris*) have been reared from *Laphygma frugiperda* at Brownsville, and only two of which (*Meteorus and Euplectrus*) have been reared from other hosts. We have not worked out the life histories of the parasites but have already started work with several of them. We have not certainly reared any parasites from *H. multilinea* but it probably has the same parasites as *H. subpunctata* as its habits and life history seem to be similar to those of that species.

As these primary parasites all have their own peculiar life histories, habits, parasites and diseases, and are differently influenced by changes in temperature and humidity, they vary very much in their abundance throughout the year and in different localities. Usually they become numerous enough in spring to almost exterminate their hosts. We have made a collection of 100 larvæ that was more than 100 per cent parasitized. *Apanteles militaris* appears to be most efficient of all these parasites but at times *A. rufocoxalis* is very numerous.

We have reared 12 secondary parasites from the primary parasites but 9 of these have been encountered in connection with *Laphygma frugiperda*. There are probably many other secondary parasites but it will require considerable time and labor to discover them.

We have reared three parasites from the cocoons of *Apanteles militaris* and they are different from those reared from *A. harnedi* and from *Meteorus*.

Meteorus of course has the same parasites that were reared from it in the work with *Laphygma* which are: *Myrmicomorpha perniciosa* Vier., *Spilochalcis pallens* Cress., *Spilochalcis delira* Cress., *Dibrachys meteori* Gahan, *Hemiteles* sp., *Mesochorus* sp., *Eupelmus meteori* Gahan, and *Elasmus apanteli* Gahan. Some of these parasites also attack *Apanteles harnedi* Vier.

Euplectrus has the parasite *Tetrastichus euplectri* Gahan in some parts of the country, but this species has not been reared at Brownsville.

Microplitis sp. has exposed cocoons like *Apanteles* and probably has many parasites but we have not reared any of them yet. *Apanteles rufocoxalis* may have the same parasites as *militaris* but we have not reared any of them from this species. It is possible that *Enicospilus purgatus*, *Rhogas atricornis*, *Ichneumon* sp., and the Tachinids may also have parasites but they pupate in the ground and are thus protected. We have reared no parasites from these species.

The primary parasites are controlled to some extent by the secondary parasites; but the most important factors in their control as well as in the control of Heliophila itself are changes in temperature and humidity. And the effect of these two factors should be worked out by a series of experiments conducted under such conditions that the various factors can be controlled. These experiments could easily be conducted with a couple of biological incubators such as are used for bacteriological work in the tropics.

A KEY TO THE CUTWORMS AFFECTING TOBACCO

By S. E. Crumb, *U. S. Bureau of Entomology*

The following key includes only the cutworms known to affect tobacco in the United States, but these include also the majority of the common species affecting other crops. For this reason it has been considered advisable to publish this table for the use of other workers in advance of a forthcoming publication of the Bureau of Entomology in which these species will be fully treated.

The characterizations of *Noctua clandestina* and of *Feltia malefida* are based upon inadequate material, and those of *Mamestra legitima* and *Peridroma incivis* as here presented might lead to some confusion, owing to the fact that it was originally intended that this key should be accompanied by descriptions and photographs of the larvæ. The larva of *Feltia ducens* (= *subgothica*) has been bred from egg to adult and no character has been found by which it may be distinguished from the larva of *Feltia jaculifera*. It seems probable that these quite similar forms are not specifically distinct. The examination of a single inflated larva of *Euxoa tessellata* has likewise revealed no character by which this species may be distinguished from *Euxoa messoria*.

In determining the character of the skin granules it should be borne in mind that the coarse granules mentioned in the key are not more than one-twentieth of a millimetre broad. A low power of the compound microscope is essential for obtaining an adequate idea of their appearance, although with a little practice the species can be determined readily with a good hand lens.

If the necessary coöperation can be secured, the writer wishes to undertake the preparation of a much more extensive cutworm key in which all our economic species might find a place. To this end material from all parts of the country, and especially live larvæ in considerable series, is very much desired; and determinations will be made when possible.

A Key to the Cutworms Affecting Tobacco

1 Paraclypeal sutures not attaining apex of head shield (Plate 20, fig. 2). Skin smooth, excepting in *Mamestra renigera* (Pl. 20, fig. 10) 2
Paraclypeal sutures attaining apex of head shield (Pl. 20, fig. 1). Setigerous tubercles rather large, distinct. Tubercle IV of abdominal segments very large (Pl. 20, fig. 4, IV). Skin granulose (Pl. 20, figs. 5, 8, 9, 11) 11

2 Head shield clear brown with solid dark fuscous above. Paraclypeal region white (Pl. 20, fig. 12) 3
Fuscous coloring of head shield limited to arcs and reticulation or absent (Pl. 20, figs. 6, 7). Paraclypeal region concolorous with remainder of head shield or merely pale, never white 4

3 Subdorsal black spots of mesothorax as large as those on seventh abdominal segment . . . . *Prodenia commelinæ* S. & A.
Subdorsal black spots of mesothorax absent or smaller than those on seventh abdominal segment . . . . *Prodenia ornithogalli* Guenée

4 Mandibles each with about 4 teeth 5
Mandibles with cutting margin straight, toothless or bearing about twelve minute teeth . . . . *Peridroma incivis* Guenée.

5 Tubercle IV of abdominal segments distinctly larger than tubercles I, II and III. Spiracles black . . . . *Mamestra meditata* Grote.
Tubercle IV of abdominal segments of about the same size as tubercles I, II, and III 6

6 Skin coarsely granulose dorsally. Tubercles I and II conical and bearing prominent bristles (Pl. 20, fig. 10). Spiracles black . . . .
Mamestra renigera Stephens.
Skin smooth, neither shagreened nor granulose. Tubercles and their setæ minute 7

7 Body without spots but prominently striped. Ground color of head shield white, submedian arcs and stemmatal stripe united posteriorly and at maxillary palpi . . . . *Mamestra legitima* Grote.
Body usually bearing black spots and never prominently striped 8

8 With triangular black subdorsal markings, at least posteriorly 9
Black subdorsal markings linear or absent. Spiracles black. With distinct yellow middorsal dots on abdominal segments, at least anteriorly . . . .
Peridroma saucia Hübner.

9 Without black spots above spiracles. Spiracles yellowish with dark rims. Ground color of head shield greyish or whitish. Dorsum drab . . . .
Noctua c-nigrum Linnænus.
With distinct black spots above spiracles 10

10 { Spiracles yellowish with dark rims. Ground color of head shield whitish.... *Noctua clandestina* Harris.
Spiracles black. Ground color of head shield pale yellowish brown.......... *Noctua badinodis* Grote.

11 { Skin granules very small, flat or slightly convex, set pavement-like, without secondary granules (Pl. 20, fig. 11)..............................12
Skin granules coarse, isolated, strongly convex or bluntly conical, interspersed irregularly with many small secondary granules (Pl. 20, figs. 5, 8, 9)..14

12 { Reticulation of head shield replaced entirely by close-set fuscous freckles (Pl. 20, fig. 6). Subspiracular white band distinct....*Euxoa messoria* Harris.
Head shield more or less fuscous-, or ferruginous-reticulate. White subspiracular band not distinct..................................13

13 { Tubercle I of abdominal segments nearly or quite as large as tubercle II.... *Feltia malefida* Guenée.
Tubercle I of abdominal segments about one-half as large as tubercle II.... *Feltia gladiaria* Morrison.

14 { Skin granules upright, conical, somewhat retrorse (Pl. 20, fig. 8). Tubercle I of abdominal segments about one-half as large as tubercle II.......... *Feltia annexa* Treitschke.
Skin granules strongly convex but scarcely subconical, not at all retrorse (Pl. 20, figs. 5, 9)..15

15 { Tubercle I of abdominal segments nearly or quite as large as tubercle II.... *Feltia jaculifera* Guenée.
Tubercle I of abdominal segments about one-third as large as tubercle II.... *Agrotis ypsilon* Rott.

Explanation of Plate 20[1]

Fig. 1. Diagram of head shield of *Feltia annexa* larva showing the paraclypeal sutures attaining apex of head shield.

Fig. 2. Diagram of head shield of *Peridroma saucia* larva showing the paraclypeal sutures not attaining apex of head shield.

Fig. 3. Diagram of the dorsum of an abdominal segment of a cutworm showing tubercles I and II. Tubercle I is anterior.

Fig. 4. Diagrammatic lateral view of an abdominal segment of a cutworm giving the notation of the setigerous tubercles. Tubercle IV is posterior to the spiracle.

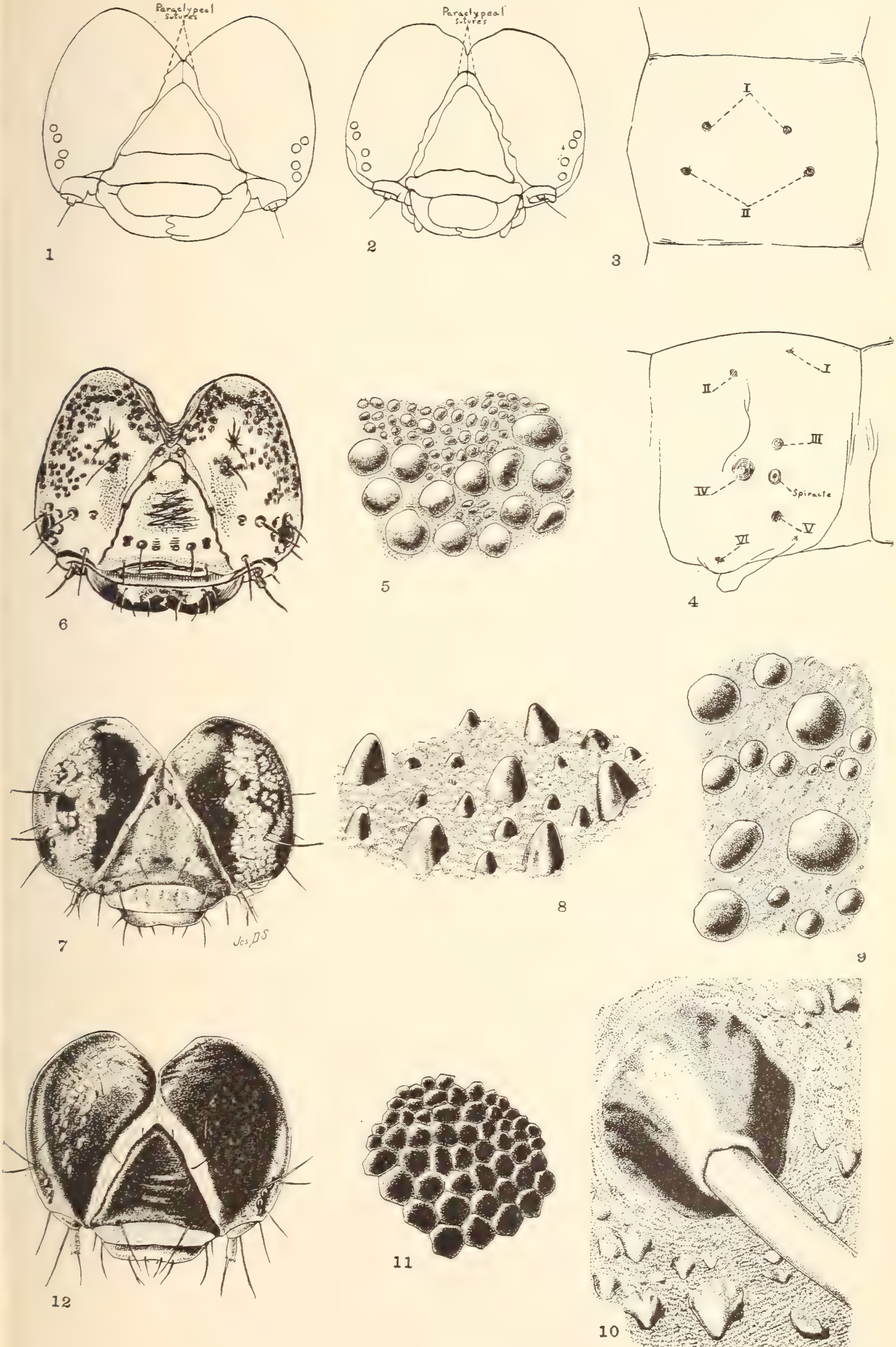
Fig. 5. Portion of the skin of *Feltia jaculifera* highly magnified showing the strongly convex, isolated, primary and secondary granules.

Fig. 6. Head shield of *Euxoa messoria* showing the submedian fuscous arcs nearly absent and the reticulation reduced to close-set fuscous freckles.

Fig. 7. Head shield of *Feltia jaculifera* showing the fuscous submedian arcs, the reticulation, and a portion of the stemmatal stripe. This is the usual coloration among cutworms.

Fig. 8. Portion of the skin of *Feltia annexa* highly magnified showing the isolated, conical, retrorse, primary and secondary granules.

[1] Figures 1–4 were drawn by Mr. Harry Bradford. The remainder of the drawings are the work of Mr. Joseph D. Smith.



Cutworm Structures

Fig. 9. Portion of the skin of *Agrotis ypsilon* highly magnified showing the strongly convex, isolated, primary and secondary granules.
Fig. 10. Portion of the skin of *Mamestra renigera* highly magnified showing one of the conical dorsal tubercles, the base of its coarse bristle, and the isolated skin granules.
Fig. 11. Portion of the skin of *Feltia gladiaria* highly magnified showing the skin granules set pavement-like without secondary granules.
Fig. 12. Head shield of *Prodenia ornithogalli* showing the black dorsal area and the white paraclypeal areas.

THE DRIED-FRUIT BEETLE

Carpophilus hemipterus (Linnæus)
(*Scarabæus hemipterus* Linnæus—Systema Naturæ, p. 351, 1758)
Order—*Coleoptera* Family—*Nitidulidæ*

By E. O. Essig, *University of California, Berkeley, California*

The dried-fruit beetle is very common throughout California and because of its attacks upon fresh ripe and dried fruits, it has become a source of some anxiety to fruit-growers and considerable worry to fruit-packers and grocers. The insect has been known to science for many years and is found in nearly all parts of the world, being a cosmopolitan species thought to have originated in Europe[1] and carried to other places in products of trade. Its fondness for dried fruits has also been known for many years, but the small number of published records concerning its work indicate that it is not generally considered to be a pest of any great importance, excepting in a few localities.

Description

Larvæ (Figure 17).—The first hatched young are exceedingly small and are white or transparently yellowish in color. The mature forms attain an average length of about one-fourth inch and are white or yellowish with the head and tip of the tail rich amber-brown. The body is quite slender, sparsely clothed with quite long spine-like hairs, and with two large tubercles at the extreme posterior end of the abdomen and two smaller tubercles just in front of the larger ones as shown in Figures 17 and 19. All stages of the larvæ are quite active, move quickly and disappear in a surprisingly short time when disturbed.

Pupæ (Figure 18).—The pupæ are short, oval or somewhat robust and about one-eighth inch long. There are many formidable looking spines on the body as shown in the drawing. The color is white or pale yellow until they are nearly mature when the dark shades of the adult are gradually assumed.

Adults (Figure 20).—The beetles are small, averaging about one-eighth inch in length and half as much in width. They are oval or robust and dull or shining black in color with two conspicuous amber-brown spots at the posterior tips and two smaller more obscure spots of the same color at the lateral marginal bases of the wing covers

[1] French, C., Jr. Dept. Agric. Victoria, IX, pp. 640–641, 1911.

or elytra. Very often the large spots run together to form a single area while the small spots may be almost entirely obliterated. In the newly emerged adults all of the spots appear like shining silver, then gradually become orange or amber-brown and finally quite dark brown. The antennæ and legs are reddish or amber. The surface of the body is finely punctured, the small circular pits being visible only under a microscope or good hand lens. From each puncture there arises a small hair. On the elytra the hairs are noticeably longer than those arising from punctures elsewhere on the body. The most conspicuous characteristic about the beetles is the very short elytra which do not reach to the tip of the abdomen, but permit the exposure of the last two abdominal segments. On the tibiæ of the legs, especially the middle and hind pairs, there are very noticeable spines as shown in the drawing (Figure 20).

Life-History

The complete life-history has not been thoroughly worked out in California, but probably does not greatly differ from those of well-known insects of similar habits. It certainly does not require a long period to complete a life cycle under favorable conditions during both summer and winter months. The eggs are laid upon the outside of the fruit or on the inside if the female can gain an entrance. The greatest numbers are deposited in the spring and hatch in about one week according to French.[1] Very often the eggs are laid upon the fruit before it leaves the trees or while it is drying upon the trays in the open before it reaches the packing sheds, which accounts for infestations before the fruit finally arrives at the storehouses. The length of the larval period varies considerably and is shortest during the warm summer months and longest under favorable conditions in winter or may be entirely retarded if exposed to cold climatic conditions during the winter as is often the case. The shortest period is about four weeks and the longest about as many months. The pupal stage is comparatively short, ordinarily requiring but two weeks.

There are many broods a year as breeding will continue throughout the year under warm storehouse conditions as are often afforded in the winter.

All stages are to be found in the fruit and no part of the package or storage bin escapes infestation.

Nature of Work

The larvæ and adults feed directly upon the fresh and dried fruits. However, the loss due to the amount of fruit actually consumed is small compared to the loss due simply to the presence of their excreta, larvæ, pupæ, adults and the moulting skins which together make a most disgusting looking mess of the infested fruit. Even if subsequently killed it is very difficult to remove the remains, which are not easily obscured from the vigil eye of the careful housewife, and

eventually the sale of the fruit comes back as a severe blow to the reputation of the packer.

Food

The insect undoubtedly attacks a larger variety of products than are to be found in the published records so that the list given can only be used as representative of the general diet rather than as being complete. The beetles are often to be found on partially decayed fruits in the orchards and in some cases pass the winter in dried and mummied fruits which cling to the trees.[1] They are also very common about the pitting sheds, drying trays, cull dumps, in the packing houses, warehouses and grocery stores, while bakeries and even the homes are not exempt.

Certain dried fruits including figs, prunes, apricots and peaches appear to be the favorite food. Prof. John B. Smith[2] lists the foods under the broad statement "baker's and grocer's supplies."

Control

The control of the dried-fruit beetle is not a difficult or expensive undertaking, but there are several factors which must not be neglected or much unnecessary expense may be required.

As in the case of many similar pests "an ounce of prevention is worth a pound of cure." As previously pointed out, this insect may attack the fruit in the orchard, on the drying trays, in the drying sheds and in the packing houses before the fruit is packed for final shipment. It is, therefore, important, to adopt measures which will insure a clean pack. But since the insect may also gain access to the package after it has left the packing house, it is equally important to pack the fruit in a container which is insect proof and which will remain so until it finally reaches the consumer. The ordinary processing of fruits, as dipping in boiling water just before packing, is sufficient to kill all stages of the insect and insure a clean pack. Sulphuring will also kill the eggs or other stages and the fruit may be kept clean by storing it in a properly screened and insect-proof room immediately upon being removed from the drying house. In such instances, however, the fruit must be dried in a regular drier under artificial heat and not in the open, where infestation during drying might easily occur. Fruit which is not processed in boiling water at the time of packing may be sterilized by heating to a temperature of about 180 degrees Fahrenheit[3] just prior to packing.

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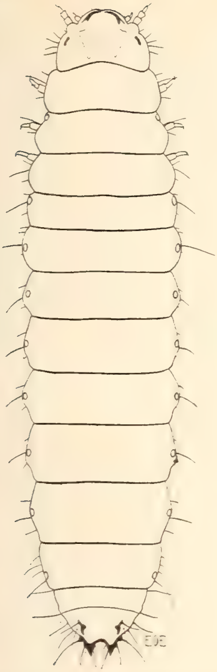
[1] Parker, W. B., Bul. No. 235, U. S. Dept. Agric., p. 5, June 24, 1915.

[2] Insects of New Jersey, p. 271, 1909.

[3] Parker, W. B., Bul. No. 235, U. S. Dept. Agric., p. 7, 1915.



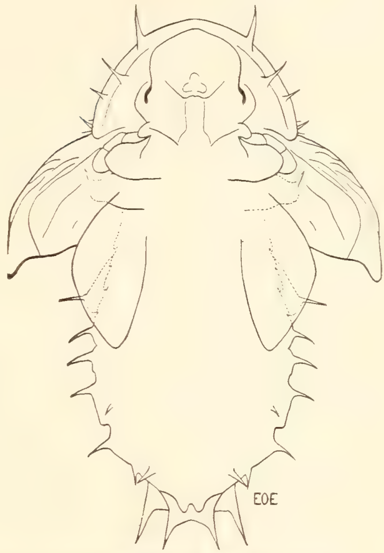
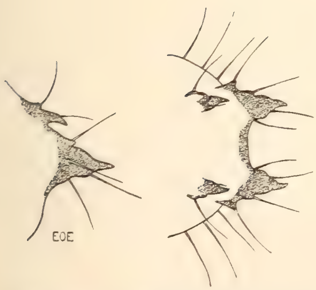


Fig. 17—Larva of the dried-fruit beetle, *Carpophilus hemipterus* (Linn.). (Original.)

Fig. 18—Outline drawing of the pupa of the dried-fruit beetle, *Carpophilus hemipterus* (Linn.). (Original.)



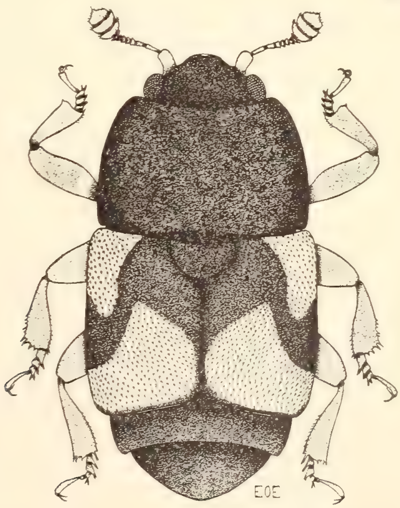


Fig. 19—Lateral and dorsal views of the posterior end of the larva of the dried-fruit beetle, *Carpophilus hemipterus* (Linn.), showing the prominent tubercles. (Original.)

Fig. 20—Adult of the dried-fruit beetle, *Carpophilus hemipterus* (Linn.). (Original.)

The use of an insect-proof package is a very important consideration in the connection with the shipment of all dried fruits, especially when packed in small cartons for retailing. A clean pack often becomes infested in the warehouse of the commission merchant or after it has reached the wholesale or the retail grocer, but no matter how it became infested, it reflects as much discredit upon the packer as if it had become infested before it left the packing house. Some recent experiments conducted by the U. S. Department of Agriculture and published in Bulletin No. 235, June 24, 1915, show that an insect-proof carton is both possible and inexpensive and has other important advantages besides those already stated.

Infested storehouses, warehouses, grocery stores, bakeries, etc., may be rid of the beetles by a thorough fumigation with hydrocyanic acid gas at the rate of 3 ounces of sodium cyanide, and the proper proportions of sulphuric acid and water, to every 100 cubic feet of air space, or better if the place is fitted with a good steam-heating apparatus, the insects may be destroyed by maintaining a temperature of 125 degrees Fahrenheit for a period of several hours. Carbon bisulfid may also be used as a fumigant at the rate of one half pound to every 100 cubic feet of air space, but as it is highly inflammable and explosive when mixed with air it is very dangerous.

Cleanliness about the pitting, drying and packing sheds is very important in reducing the numbers of beetles which are likely to infest the fruit and the storage bins and warehouse should be thoroughly renovated before storing the new crop. Fruit from the previous year should be carefully inspected and removed, treated or destroyed if found infested.

Department of Entomology,
University of California,
Berkeley, California,
July 15, 1915.

FUMIGATION METHOD FOR SACKED COTTON SEED

By W. E. Hinds, *Entomologist, Auburn, Ala.*

In connection with the administration of the boll weevil quarantine, it has frequently been necessary to fumigate considerable quantities of cotton seed originating in boll weevil infested territory to make it safe to allow shipments of such seed to points outside of the infested area. In the course of the boll weevil investigations more than ten years ago, it was found that carbon disulphide was the most practicable material for such fumigation work. Hydrocyanic acid gas has very

little penetrative power in cotton seed. This material, on account of its texture, is extremely resistant to gas diffusion. Carbon disulphide vapor, however, penetrates quite readily through masses of cotton seed and is retained by the seed sufficiently long to make it a very effective protection against the transmission of living boll weevils in seed shipments.

The problem of application of the liquid to the seed was partially worked out and the method described in Farmers Bulletin 209 published in 1904. The method therein outlined involved practical difficulties in application on a large scale as the rapid evaporation of the liquid lowered the temperature to below the freezing point, thus freezing water that might be contained in the liquid disulphide and clogging the pipes.

The method herein described has been worked out in Alabama and used quite extensively in the treatment of cotton seed grown for planting purposes. With this method it has been found possible to treat 600 or more sacks per day with four men to do the work. Two men handle the application of the liquid, the method followed being shown quite clearly in the illustration. The other two men mark the sacks and pack them away after the treatment is given. Our method of dealing with seed for planting is to mark each treated sack with the initials of the man in charge of the fumigation work, the date of the treatment and serial number of the sack; *e.g.*, A. B., 1–20–'15, No. 1, *et seq.* When shipping out fumigated seed, the grower could indicate upon the certificate accompanying the way-bill for the shipment, the numbers of the sacks included and this would constitute a positive identification and guard against the shipment of untreated seed. This method protects both the grower and buyer of the seed.

The apparatus consists essentially of a 3″ air pump by which the liquid and vapor can be forced quickly into and through the seed. This is connected by pressure tubing with one branch of an ordinary $\frac{1}{4}''$ *Y* such as is used in spraying work. On this branch there is a cut-off, also a regular spraying accessory. The other branch of the *Y* has a similar cut-off and bears at its outer end a quarter turn with a metal cup at the top just large enough to hold, or so marked as to indicate accurately, the amount of liquid required for each sack. The *Y* is connected with a piece of $\frac{1}{4}''$ galvanized gas pipe about $3\frac{1}{2}$ ft. long, closed at the distal end with a metal plug sharpened to a point so that it will penetrate readily through the bagging and seed. For a distance of 18 inches back from this end the tubing is perforated in various directions and at distances of a few inches apart with a number of small openings through which the liquid and vapor are distributed so that it may diffuse through the sack in all directions. This type of

tube is for use with the ordinary three-bushel sack. Almost any convenient receptacle may be used that will hold a quart or more of carbon disulphide and from which it may be readily poured into the metal cup. A one-gallon kerosene can is a convenient thing for this work but a different arrangement is shown in the illustration.

The method of procedure is as follows: Drive the perforated rod into the sack of seed to the proper place, close the cut-off on the cup side of the *Y* and pour in the proper charge of liquid. Then open the cut-off and permit the liquid to run down into the pipe, closing the cut-off immediately thereafter and opening that on the air side of the *Y*. Two or three strokes from the air pump will be sufficient to force the liquid and gas into the seed and the perforated tube is then withdrawn. Care should be taken to have the cut-off closed on the liquid side of the *Y* to prevent the air pressure forcing the liquid back into the face of the operator.

The treated sacks are closely stacked, preferably in a small room which is sufficiently tight so that the entire room may be given a regular treatment with disulphide as a final precaution. The seed is left stored in this room until shipped. This method of treatment has given entirely satisfactory results and is economical, both in the cost of apparatus and in the amount of liquid required. The method of treatment can, of course, be readily adapted to many other subjects beside sacked cotton seed. In treatment of cotton seed, our practice is to use one ounce of carbon disulphide per three-bushel sack of seed.

NOTES ON AN APPARENT RELATION BETWEEN APHIDS AND FIRE BLIGHT (BACILLUS AMYLOVORUS)

By J. H. Merrill, *Assistant Entomologist, Kansas Agricultural Experiment Station*

Observations on this subject have been carried on since the spring of 1913 in Doniphan County by the Department of Entomology of the Kansas Agricultural Experiment Station. During the spring of 1913 the aphids were noticed to be unusually abundant in nearly every orchard, especially on the Jonathan trees. They were found on the buds which had begun to swell but were not completely opened. Some of the fruit-growers, realizing that nothing but harm could result where so many sucking insects were present, sprayed with a contact insecticide to control them. Very few aphids were found in the orchards which had received a thorough dormant spraying with lime-sulphur.

Fire blight appeared later in the season in all of the orchards where

Fumigating Cotton Seed

the aphids were not brought under control. The infestation of aphids was heavier on Jonathans than on any other variety, and the blight infection was correspondingly heavy on the same trees. During the season of 1914 there was but a slight infestation of aphids and very little blight made its appearance. However, the infestation of aphids in the spring of 1915 was as severe as that in the spring of 1913. Profiting by their experience in 1913 the growers who controlled the aphids then sprayed their trees with Black Leaf 40 upon the first appearance of these insects. Others also joined them in using this spray. Although the fire blight was exceptionally abundant in 1915, only those orchards suffered in which the plant lice were not controlled. Observations were carried on in both Wathena and Troy and the results were the same in both places. Orchards in which the crops were a total loss in 1913 from fire blight injury were sprayed in 1915 with a contact insecticide and today show but very little blight, while the orchards which were not similarly treated look as though they had been swept by a fire. In one orchard part of a block of Jonathans was sprayed with Black Leaf 40 and the remainder left untreated. The latter portion is now badly infected by fire blight while the sprayed portion is practically free.

Doniphan County, which is primarily a fruit-growing district, has offered excellent opportunities for carrying on these observations. The Jonathan trees have always shown more aphids and later more blight than the other varieties, yet when these same trees have been treated with a contact insecticide the aphids were controlled and they showed but little blight injury.

It is not the intention to claim here that the aphids are the only distributers of fire blight but rather to give the facts resulting from experiments carried on to control these insects. These facts seem to show that there is a direct relation between the severity of the infestation of aphids and the blight infection. Work along these lines is now being continued.

TWO INTRODUCED WORMS OF ECONOMIC INTEREST

By H. Garman, *Head of Division of Entomology and Botany, Kentucky Experiment Station*

Helminthology is so closely related with entomology and worms so frequently arouse the interest of the economic entomologist when found doing mischief where insect injury was suspected, that it may not be out of place to call attention to a couple of interesting species, one a flat worm, the other a round worm, which appear to have been somewhat recently introduced into this country.

Bipalium kewense.—June 22, 1915, a florist of Lexington brought me a fine specimen of this giant land planarian which he found in soil about plants in his hothouse. When extended it measured over seven inches in length, the body being flattened, unsegmented, slimy, and about 0.18 inch (4.5 mm.) in greatest width. The head is a singular leaf-like structure capable of being greatly distended and widened, and as the animal moves is kept swaying about like a great lip. It is not notched as represented in Dr. Gamples' Platyhelminthes, p. 34 (The Cambridge Natural History Series).

The general color is brown, the dorsal side with a narrow black median line, with two broader less well-defined lines on each side of it, the outer one of each side lying close along the margin of the body. Beneath, the body is marked by two obscure longitudinal dusky lines, one on each side of the middle line.

Just where the worm comes from is problematical. It is said to occur in the forests of Samoa, and may be native there. It has frequently been introduced into England and other European countries with plants, and we may surmise that it has been brought thus into the United States. This is the second instance of its occurrence at Lexington, the first specimens, of which there were two, being brought to me by a florist in 1905.

We have nothing like this flat worm so far as I know among our native species. It is formidable in appearance, but may prove not to be a pest. The common aquatic species of this part of the United States commonly measure less than a half inch in length.

Heterodera schachtii.—In 1910, I received from a former student of Kentucky State University a sample of sugar beets from Spreckles, California, badly infested with the European Eel worm, and which was reported to be a very destructive pest to sugar beets grown on the Spreckles sugar plantations. My correspondent wrote of the infestation:

"At present the nematode patches are not large and we hope to get them under control before they spread further. Infested areas are clearly defined in the beet fields. The plants wilt down during the heat of the day but revive during the night. On the infested roots can easily be seen the swollen bodies of the females filled with eggs."

It will be recalled that the Bureau of Entomology published some years ago a bulletin on the Root-knot worm (*Heterodera radicicola*) of the South Atlantic states, and of hothouses north. The western species works very differently, but is, if anything, more destructive. I have been expecting to hear from it in the eastern states. Has anyone encountered it there?

Lexington, Kentucky,
June 26, 1915.

NEW GALL MIDGES

By E. P. Felt, *Albany, N. Y.*

This paper characterizes a number of new and recently reared gall midges. Among these may be found one referable to a genus not hitherto recognized as American, and another belonging to a genus recently erected by a well known European authority, Dr. Kieffer, based upon a fairly well known American species.

Prionellus monilis Felt.—Several females agreeing very closely with the type were collected May 1, 1914, by Prof. J. M. Aldrich at Lafayette, Ind., while sweeping winter wheat. The male was unknown and is described from this material.

Male.—Length, 1 mm. Antennæ nearly as long as the body, sparsely haired, light brown; 14 segments, the fifth with the stem about three-fourths the length of the rounded-pyriform basal enlargement, which latter has a length about one-third greater than its diameter; two indistinct crenulate whorls with a rudimentary third and subapically a whorl of four, somewhat fusiform sensory organs, probably rudiments of the distinct collar of the female; terminal segment reduced, narrowly oval, obtusely rounded apically. Palpi; first segment irregularly quadrate, the second broadly oval, the third one-half longer than the second, more slender, the fourth nearly twice as long as the second, more slender. Mesonotum dark shining brown. Scutellum, postscutellum and abdomen dark reddish brown. Halteres whitish transparent. Legs mostly fuscous yellowish, the distal tarsal segments somewhat darker; claws strongly curved, finely denticulate, the pulvilli longer than the claws. Genitalia; basal clasp segment short, stout; terminal clasp segment short, greatly swollen, with a length less than twice its diameter; dorsal plates long, broadly rounded; ventral plate obscure. Harpes strongly chitinized, approximate at the distal third, the acute apices divergent. Cecid. 1582.

Dasyneura torontoensis n. sp.—A number of small midges were reared from *Maianthemum canadense*, May 3, 1915, by Dr. A. Cosens, Toronto, Can., from a root gall. Later in connection with the subterranean habits of the species, Dr. Cosens writes that he was unable to detect any attempt to fly on the part of the adults. The gall is fusiform, monothalamous and has a length of 7 mm., a diameter of 1.5 mm. and is inhabited by a whitish larva.

This species runs in our key to *Dasyneura piperitæ* Felt, from which it may be separated by the decidedly shorter terminal antennal segment and the shorter fourth palpal segment. There are also colorational differences. Only the female has been reared.

Larva.—Length, 1.4 mm., whitish, stout, the skin coarsely shagreened and transversely wrinkled. Head rather narrow, roundly acute, the antennæ long, tapering, with a length thrice the diameter; breastbone bidentate, strongly chitinized, slightly expanded basally; posterior extremity of body probably roundly truncate and with a pair of submedian, tapering, fleshy processes.

Female.—Length 1.5 mm. Antennæ extending to the third abdominal segment, sparsely haired, yellowish or dark brown, yellowish basally; 14 segments, the fifth subsessile, cylindric, with a length one-half greater than its diameter, the terminal segment somewhat reduced, broadly oval and with a length three-fourths greater than its diameter. Palpi; the first segment irregularly subquadrate, the second with a length a little greater than twice its diameter, the third one-half longer than the second, slender, the fourth one-half longer than the third, slender. Eyes black. Mesonotum dark brown, the sparsely haired submedian lines yellowish; in one specimen the mesonotum is fuscous yellowish. Scutellum and postscutellum yellowish. Abdomen yellowish orange, the ovipositor about half the length of the body, the terminal lobes sparsely setose, slender, slightly constricted near the basal third and with a length about four times their width. Halteres yellowish basally, slightly fuscous apically. Coxæ, femora and tibiæ mostly pale straw, the tarsi mostly dark brown; claws slender, strongly curved, the pulvilli as long as the claws. Type Cecid. a2620.

Asteromyia ? læviana Felt.—One female midge resembling, in a general way at least, the male of this species, was reared from a similar gall on *Aster saggittifolius*, July 15, 1913, by Dr. A. Cosens, Toronto, Ont., Can.

Female.—Length, 1 mm. Antennæ extending to the base of the abdomen, sparsely haired, dark brown; at least 14 and probably 15 or 16 segments, the fifth with a length about equal to its diameter. Palpi invisible in the preparation, probably uniarticulate. Mesonotum shining black, the submedian lines sparsely haired. Scutellum shining dark brown, sparsely haired apically, postscutellum yellowish brown. Abdomen a nearly uniform black, the third to sixth abdominal segments narrowly margined posteriorly with whitish scales. Wings hyaline, the third vein uniting with the margin near the basal half. Halteres yellowish, the club narrowly fuscous basally. Coxæ reddish brown; femora yellowish basally, fuscous apically. Tibiæ and tarsi fuscous. Ovipositor about half the length of the abdomen, stout, the terminal lobes orbicular, minor lobes linear, both thickly setose. Cecid. a2440.

Feltiella davisi n. sp.—The small midges described below, tentatively referred to this genus, were reared June 19, 1915, from catnip leaves infested with *Aphis gossypii* Glov. and forwarded, June 15, by Dr. J. J. Davis of Lafayette, Ind. The adults present all the characters of this genus, heretofore not recognized in America, except that the palpi appear to be triarticulate, and even in this organ the terminal segment is indistinctly divided and apparently composed of two closely fused, probably rudimentary segments.

Male.—Length, .8 mm. Antennæ one-half longer than the body, thickly haired, fuscous yellowish; 14 segments, the fifth having the stems each with a length about two and one-half times their diameters, the distal enlargement short and with a length about one-fourth greater than its diameter; terminal segment wanting in the preparation. Palpi; the first segment irregularly quadrate, the second with a length about one-half greater than its diameter, the third twice the length of the second, fusiform and indistinctly divided. Mesonotum brownish yellow. Scutellum yellow, postscutellum fuscous yellow. Abdomen mostly a light fuscous yellowish with a reddish brown spot basally. Wings hyaline, the third vein uniting with the margin

just before the apex. Halteres mostly fuscous yellowish. Coxæ and femora basally whitish transparent, the femora distally slightly fuscous; tibiæ and tarsi mostly pale straw; claws slender, evenly curved, longer than the pulvilli, the anterior unidentate. Genitalia; basal clasp segment long, slender, basally with a large internal, curved, subtriangular setose lobe; terminal clasp segment moderately stout and rather short; dorsal plate short, deeply and triangularly emarginate, the lobes obliquely rounded; ventral plate broad, broadly rounded apically; style long, tapering to a narrowly rounded apex.

Female.—Length, .8 mm. Antennæ three-fourths the length of the body, sparsely haired, fuscous yellowish; 14 segments, the fifth with a stem one-fourth the length of the cylindric basal enlargement, which latter has a length two and one-half times its diameter; terminal segment somewhat produced, slightly constricted near the basal third, narrowly rounded apically. Palpi; the first segment irregularly quadrate, the second with a length more than twice its diameter, the third one-half longer than the second, slightly constricted near the basal third. Mesonotum brownish yellow. Scutellum yellowish, postscutellum brownish yellow. Halteres mostly yellowish or yellowish orange. Coxæ and femora mostly yellowish transparent; tibiæ pale straw; anterior and mid tarsi dark fuscous yellowish, the posterior tarsi pale yellowish. Ovipositor short, the terminal lobes roundly triangular and rather thickly clothed with coarse setæ. Other characters practically as in the male. Type Cecid. a2643.

Mycodiplosis fungiperda n. sp.—The pale yellowish, black-eyed midges described below were reared by Theodore Pergande September 24, 1896, from orange-colored or whitish larvæ occurring in a large, yellowish fungus growing on rotten bark. This species is described through the courtesy of Dr. Howard of the Bureau of Entomology. Mr. Pergande states that the fungus was infested by millions of the larvæ, which jumped about like flies, even to a distance of five or six inches and displayed an evident preference for the light.

Male.—Length, 1.2 mm. Antennæ nearly twice the length of the body, thickly haired, pale yellowish; 14 segments, the fifth with stems twice the length of their diameters. Palpi; first segment short, subquadrate, the second with a length three and one-half times its diameter, slender, the third a little longer and more slender, the fourth as long as the third; entire body pale yellowish. Wings whitish transparent. Halteres yellowish, slightly reddish apically. Legs pale straw; claws long, slender, evenly curved. Genitalia; basal clasp segment long, moderately stout; terminal clasp segment long, tapering; dorsal plate short, deeply and triangularly emarginate, the lobes triangular; ventral plate short, broad, tapering, broadly emarginate; style short, narrowly rounded.

Female.—Length, 1.2 mm. Antennæ nearly as long as the body, sparsely haired, pale yellowish; 14 segments, the fifth with a stem about three-fourths the length of the subcylindric basal enlargement, which latter has a length about twice its diameter, penultimate segment produced, the basal enlargement with a length thrice its diameter, apically a rudimentary segment; ovipositor short, the lobes narrowly oval. Other characters practically as in the male. Type Cecid. 1315.

Paralellodiplosis corticis n. sp.—This pale yellowish form was reared by C. V. Riley from larvæ occurring in oak bark.

Male.—Length, 1 mm. Antennæ a little longer than the body, thickly haired, yellowish; 14 segments, the fifth with stems two and one-half and three times their diameters, respectively; terminal segment produced, the distal enlargement stout, cylindric, with a length nearly three times its diameter and broadly rounded apically. Palpi; first segment short, subquadrate, the second with a length three times its diameter, the third a little longer, slightly dilated, the fourth one-fourth longer than the third, slender. Thorax and abdomen pale yellowish, the base of the latter somewhat tinged with orange. Wings yellowish transparent, costa pale yellowish. Halteres yellowish transparent. Legs yellowish; claws slender, strongly curved, simple, the pulvilli shorter than the claws. Genitalia; dorsal plate short, deeply and narrowly emarginate, the lobes obliquely emarginate; ventral plate long, tapering, slightly, subtruncate; style long, narrowly rounded. Type Cecid. 1075.

Retinodiplosis Kieff.—The genus Retinodiplosis, erected by Kieffer in 1912 with *Cecidomyia resinicola* O. S. as the type, represents a well-defined group comprising such pitch-inhabiting forms as *Cecidomyia inopis* O. S., *C. resinicoloides* Wlms. and the closely allied species characterized bleow.

Members of this genus are mostly dark red or reddish-brown and may be recognized by the short, almost transverse basal stems of the flagellate antennal segments, the rather long, broad, distal enlargement, and the fine, short, many-looped circumfili in connection with the rather heavy genitalia, the two plates being usually deeply bilobed. The larva is easily recognized, in that the posterior extremity is bilobed, the apex of each lobe being fuscous, heavily chitinized, and strongly spined, an adaptation which permits the larva to extend its anal spiracles, located in these lobes, through the surface of the viscous resin it inhabits.

Retinodiplosis palustris n. sp.—The midges described below were reared May 20, 1915, from pitch on twigs of the long-leaved pine collected by Dr. J. J. Davis at Talladega, Alabama, April 9 of the same year. The species is closely related to *R. resinicoloides* Wlms. from which it may be separated by the longer basal portion of the stem of the flagellate antennal segment and the distinctly greater emargination of the ventral plate.

Exuvium.—Length, 3 mm., the mesonotum and wing-pads fuscous yellowish, the antennal and leg cases lighter; abdomen semi-transparent.

Male.—Length, 3.5 mm. Antennæ probably nearly as long as the body, sparsely haired, reddish brown; 14 segments, the fifth having the stems with a length one and one and one-half times their diameters, respectively; distal enlargement subcylindric, with a length one-fourth greater than its diameter, the circumfili moderately short, stout and with numerous loops; terminal segment, distal enlargement produced, with a length about twice the diameter, a constriction near the middle and a somewhat irregular, fingerlike process apically. Palpi; the first segment subquadrate, with a length nearly twice its diameter, the second nearly twice the length of the first, the third a little longer than the second, and the fourth a little longer than the third. Mesonotum dark brown, the submedian lines short, silver-haired. Scutellum reddish

brown, postscutellum dark brown. Abdomen dark reddish-brown; genitalia with a reddish cast. Wings hyaline, costa reddish brown. Halteres reddish brown, yellowish basally. Coxæ reddish brown, the legs mostly pale straw, the tarsi slightly darker; claws moderately stout, slightly curved, simple, the pulvilli longer than the claws. Genitalia; basal clasp segment moderately long, stout; terminal clasp segment short, tapering and curving apically; dorsal plate short, broad, broadly and triangularly emarginate, the lobes somewhat divergent and broadly rounded; ventral plate long, broad, deeply, roundly and triangularly emarginate, the lobes tapering to a narrowly rounded, setose apex.

Female.—Length, 4 mm. Antennæ probably extending to the third abdominal segment, sparsely haired, reddish-brown; 14 segments, the fourth with a stem one-fourth the length of the subcylindric basal enlargement, which latter has a length two and one-half times its diameter and is slightly expanded apically. Palpi; the first segment roundly triangular, the second with a length more than three times its diameter, the third a little shorter than the second and the fourth one-half longer than the third. Abdomen reddish-brown. Ovipositor short, with a length less than one-third the abdomen, the terminal lobes narrowly oval and thickly setose. Type Cecid. a2622.

Described from balsam preparations, colors approximate.

THE RHODODENDRON LACE-BUG, LEPTOBYRSA EXPLANATA HEIDEMANN

(*Tingitidæ, Hemiptera*)

By C. R. Crosby and C. H. Hadley, Jr., *Ithaca, N. Y.*[1]

As early as 1906, this tingid had been noted as being abundant and causing considerable injury to rhododendrons in several localities in New York. In 1908, Heidemann described it as a new species, adopting the manuscript name of Professor Uhler, *Leptobyrsa explanata*. Since then its presence has been observed every year, often being abundant enough to cause serious injury.

Distribution

This insect is more or less widely distributed from North Carolina to Massachusetts, and as far west as Ohio. It has been found in the following states: North Carolina, Maryland, District of Columbia, Pennsylvania, West Virginia, Ohio, New Jersey, New York, Connecticut and Massachusetts, and is probably present in others also. In New York it is found in a number of places.

Hosts

This insect has been recorded as abundant on mountain laurel, *Kalmia latifolia*, and rhododendron or great laurel, *Rhododendron*

[1] Contribution from the Department of Entomology of Cornell University.

maximum. We have observed it breeding abundantly on rhododendron in the Rochester parks and in private grounds at Ithaca.

We have also received specimens from nurseries at Lynbrook, Long Island, on rhododendron, and from Franklin Park, Boston, Mass., on mountain laurel. In April 1908, eggs were found in abundance on wild rhododendron at Port Jervis, N. Y.

Injury

The leaves are disfigured on the underside along the midrib by the brownish scabs which cover the eggs, as described below. The greatest injury is caused by the nymphs and adults feeding on the under surface of the leaf. They suck the sap, causing a lighter colored spattered appearance on the upper surface, often with consequent drying and shriveling of the leaf. The sale of rhododendrons is also sometimes hindered by the unsightly appearance of the undersides of the leaves, due to the excrement left there by the insects.

Life History

Egg.—5.54 mm. long by .24 mm. wide. It is flask-shaped with the neck bent to one side. The anterior end is obliquely truncate and provided with an oval lid. This lid has a submarginal ridge which encloses an oval impressed area. The egg is smooth,without sculpture, and is white, except near the anterior end where it is somewhat brownish. The eggs are usually inserted in a more or less irregular row along the midrib on the underside of the leaf, but occasionally in the leaf a short distance away from the midrib, on either side. The leaf tissue surrounding the egg becomes hardened and corky, but this hardening is entirely internal and makes no noticeable change on the surface of the leaf. In removing the egg with a needle, this gall-like growth is easily separated from the normal tissue. The lid is nearly on a level with the leaf surface and is protected by a drop of a brownish substance deposited by the parent insect, and has the appearance of a small scab. When the eggs are abundant, these scabs are quite noticeable along the underside of the leaf. Often these scabs drop off several days before the eggs hatch, exposing the egg cap. The eggs are laid in the newer leaves, and the winter is passed in this stage.

Nymph.—At Ithaca, the eggs hatch in late May or early June, depending on the weather. They have been observed hatching outdoors on June 6, and had apparently all hatched by June 17. In 1908, first, second and third stage nymphs were observed out of doors on June 2.

Explanation of Plate 22

1. Injured and uninjured leaves, showing eggs and disfiguring on underside of leaf.
2. Eggs in position in leaf tissue.
3. Location of eggs along midrib.

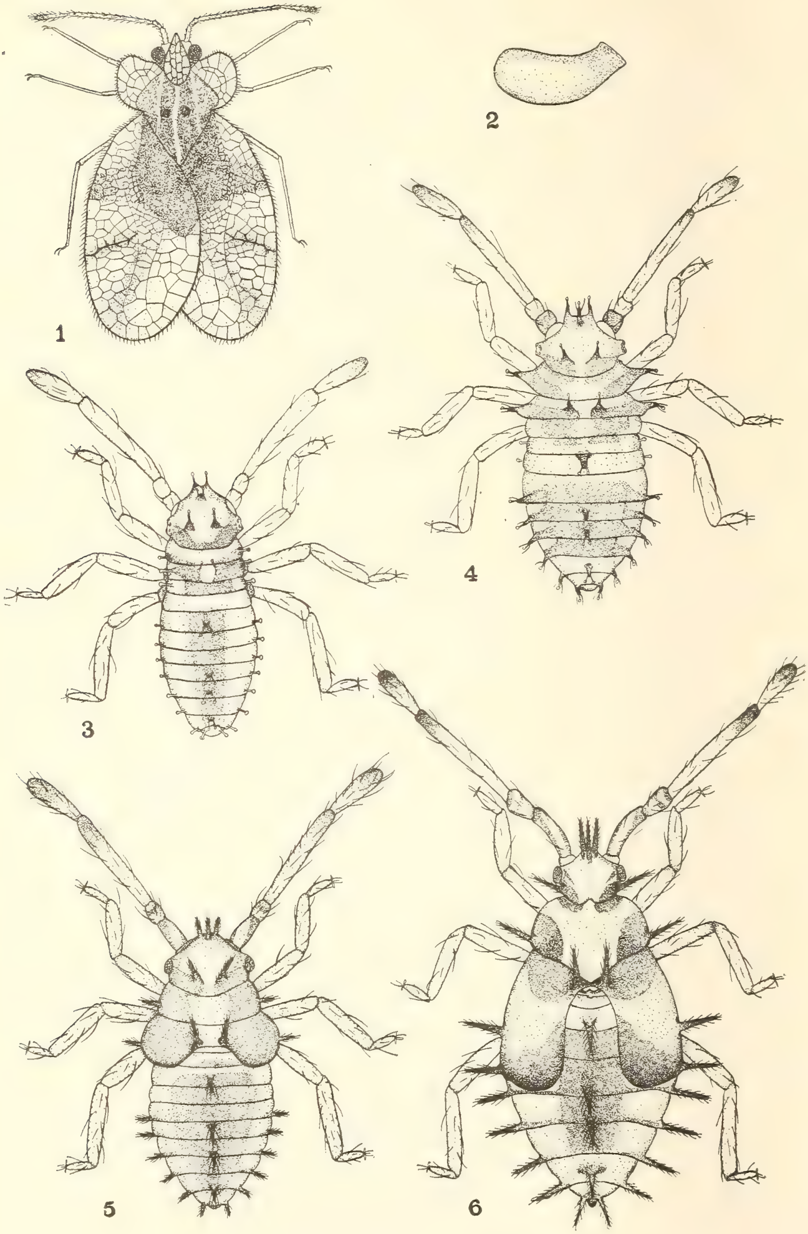
Mr. Dunbar states that he observed the young nymphs on May 25, 1906, on rhododendrons in Hyland Park, Rochester, N. Y. In hatching, the end of the egg enlarges slightly, becoming almost transparent. Then the nymph gradually emerges, the red eye-spots showing very conspicuously. The body sways back and forth slowly, during emergence, with slight spasmodic movements. When all the body has emerged except the last two or three segments, the spines along the sides of the body and the legs unfold and stiffen out. Then the leaf surface is grasped by the claws of the legs, and the insect is able with this help to withdraw the body entirely. Often the egg shell is drawn partly out of its pocket by this last effort. The newly emerged insect rests for several minutes after its exertions, then it slowly walks around, seeking a suitable feeding place. When first emerged the nymph is colorless, almost transparent, except for the bright red eyes. Soon after feeding commences, it begins to darken up.

The nymphs feed in groups, remaining in a place a short time, then moving to a new location. The characteristic feeding attitude is with the body inclined upward towards the head, the antennæ straight outward slightly diverging. At intervals the body sways slightly from side to side. After feeding a short time, the proboscis is withdrawn, and the slender inner sucking tube is carefully cleaned with the forefeet, in much the same fashion as the ordinary house fly.

Description of Nymphal Stages

First stage.—Length, 0.75 mm. At first nearly colorless but gradually becoming darker at base of legs and at base and tip of antennæ and beak, abdomen appearing greenish from the ingesta. Head rounded in front, narrowed behind the eyes, armed with five strong tubercles, two above the base of beak, one just behind these bearing two hairs and two near the posterior margin. Eyes consisting of five distinct ommatidia, bright red, prominent. Thorax a little narrower than abdomen. On each thoracic segment and on each abdominal except the first there is on each side near the lateral margin a simple hair borne on a minute tubercle. On the mesothorax there is a median pair of small hairs. On abdominal segments 2, 5, 6 and 8 there is a large double median tubercle bearing at its tip two short hairs. All these hairs secrete a sticky substance which hangs as a clear drop at the end. Antennæ three-fourths the length of the body, four-jointed, the two basal segments short, third the longest, fourth slightly more than half as long as the third. Beak in newly hatched specimens nearly as long as body, after feeding reaching only to second abdominal segment.

Second stage.—Length 0.9 mm. In general much like first stage except that lateral margin of abdomen is slightly more explanate and the dusky parts have become darker. Abdomen and lateral part of thorax dusky. The tubercles on the head are much longer, quite slender and of a dusky color. The lateral tubercles on the pro- and mesothorax and on abdominal segments 4–9 are much larger, those on the metathorax and on abdominal segments 2 and 3 are small. There seems to be no tubercle on the first abdominal segment. The dorsal tubercle is much larger than in preceding stage and bears four or five hairs. The dorsal abdominal tubercles are much larger and bear a cluster of hairs, the one on the second segment being smaller than the



Rhododendron Lace Bug

others. Towards the last of this stage two small ommatidia begin to show on the anterior side of the group.

Third stage.—Length including tubercles on head 1.4 mm. Outer side of first, tip of second, third and fourth joints of antennæ, all the large tubercles on body, wing-pads and dorsum of abdomen dusky with a greenish tinge. The outline of the eye is now distinct and the ommatidia numerous, red. The wing-pads are conspicuous and extend to second abdominal segment. The tubercles which had increased in size in the preceding stage have become still larger and bear more glandular hairs while the smaller areas seem to have become obsolete.

Fourth stage.—Length including tubercles on head, 2.25 mm. All tubercles have become longer, more slender and are dusky. The sides of prothorax are more explanate, the posterior margin is slightly biconcave, while the rounded median portion extends between the mesothoracic tubercles. The wing-pads extend to the fifth abdominal segment; the lateral tubercles of the mesothorax occupy the extreme margin of the wing-pad and are nearer the apex than the base. Color dull yellowish; base and tip of wing-pads, large oval spot on abdomen, spots at base of tubercles and outer side of first, tip of second and third, and distal two-thirds of fourth segment of antennæ dusky with a greenish tinge. Legs dull yellowish, tip of tarsi dusky.

Under insectary conditions, the length of the nymphal stages has been found to be as follows:

First stage, 6 to 7 days;
Second stage, 4 to 6 days;
Third stage, 3 to 6 days;
Fourth stage, 12 to 15 days.

Under outdoor conditions, the length of stages is probably a little greater, as adults have been seen mating on July 20, and laying eggs on July 25.

Adult.[1]—Body short, oval in the female, more elongate in the male, shining black; membranous parts of pronotum and integument of elytra pale yellowish, semitranslucent, nervures yellowish. Head rather small, black, with three white frontal spines, two approaching each other, the middle one comparatively stouter; besides, there are two other more slender spines extending from behind the eyes towards front. Antennæ long, finely pilose, yellowish, the tips infuscated; two basal joints slightly thicker than the following ones, first joint twice the length of second, third little more than three times as long as fourth. Bucculæ yellowish, narrow, angulate and broader behind, the edge upturned a little. Pronotum transverse, feebly convex, coarsely punctured, and shining black; in fresh specimens the sides of the pronotum are covered

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EXPLANATION OF PLATE 23

Leptobyrsa explanata Heid.

Fig. 1. Adult.
Fig. 2. Egg.
Fig. 3. First stage nymph.
Fig. 4. Second stage nymph.
Fig. 5. Third stage nymph.
Fig. 6. Fourth stage nymph.

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[1] Heidemann, O. Proc. Ent. Soc. Wash. X, 105–108.

with a whitish film that also extends toward the underside at the sternum. Hood not much inflated, cristate and slightly tapering towards front; covering the head, except the eyes, with quite large areoles at the sides near top and a few smaller ones at lower part. The three pronotal carinæ yellowish,the median one strongly declining towards apex of the triangular posterior portion of pronotum, with a row of long, large areoles of which the middle ones are divided by a few cross nervures and embrowned; outer carinæ very low, only half as long as the median carina, extending from base of hood to sides of pronotal portion posteriorly; the triangular part of pronotum rather short, yellowish and finely reticulated; membranous pronotal margins strongly rounded behind, reflexed, widening moderately at sides, narrowing toward the neck and reaching the lower part of hood close to the eyes, with two or three rows of average-sized areoles. Elytra ovate, iridescent, extending one-half their length beyond abdomen, a little less in the male; discoidal area pyriform and short, angularly raised at the outer nervure, somewhat rounded at apex and broadly scooped out on the upper surface, with three or four rows of quite large areoles at the widest part. Subcostal area subvertical, wider than the discoidal area, having about five rows of irregular small areoles, those of the upper row much larger; costal area broadly expanded, with four or five rows of very large, more or less irregular areoles, diminishing to three and two rows at base. Surface of elytra very peculiarly undulated, with two transverse, sharp impressions, and another at apex formed by the outer nervure of subcostal area; a light transverse fascia on basal half. Median nervure of subcostal area strongly sinuate towards tip of elytra; sutural area at inner part irregularly reticulated with rows of some extremely large areoles. Entire margin of elytra, lateral margins of pronotum, crest of hood, carinæ, and most of the nervures beset closely with long, very fine hairs. Rostral groove uninterrupted, broad at mesosternum and metasternum, angularly closed in front; rostrum reaching metasternum. Abdomen of female broadly rounded at apex, in the male more elongate, the sides of genital segment sinuated; at tip two strong claspers. Length 3.6 mm.; width of each elytron across widest part, 1.4 mm.

Control

Our experience has shown that it is not a difficult matter to control these insects. They may be killed by a soap and water spray, at the rate of 1 pound soap to 10 gallons water. The spray should be directed at the under side of the leaves, and applied as soon as the nymphs are observed. It may be necessary sometimes to spray more than once during the season. Any good soap may be used without injury to the leaves. In the case of rhododendron, care should be taken not to spray the plants while the hot sun is shining; otherwise the leaves will be scorched.

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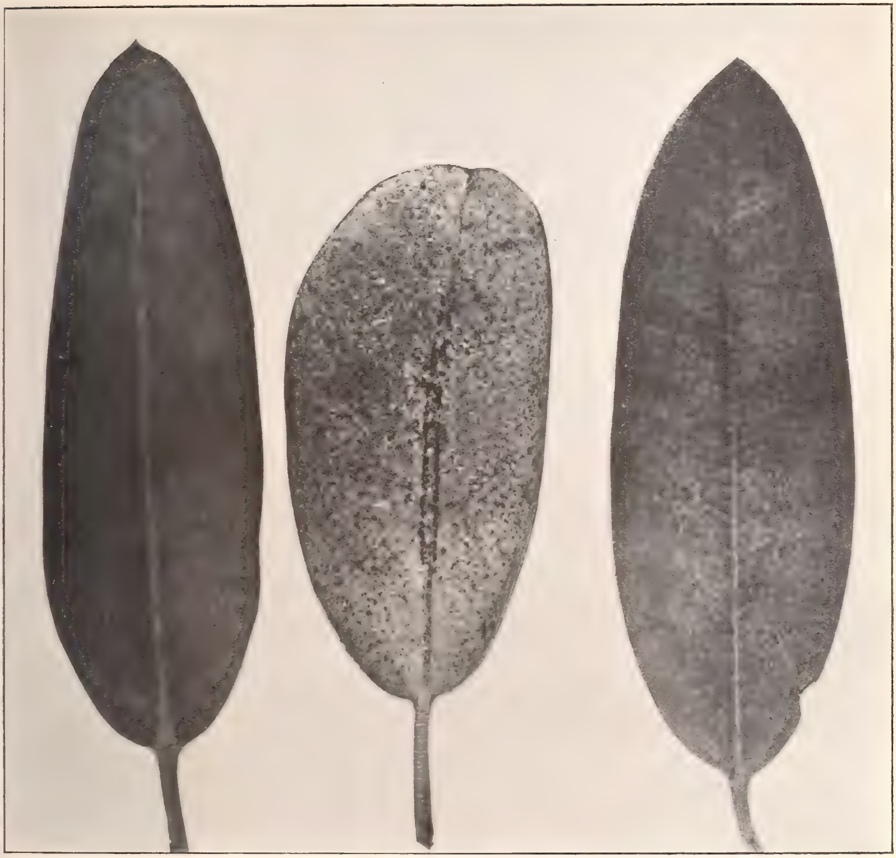

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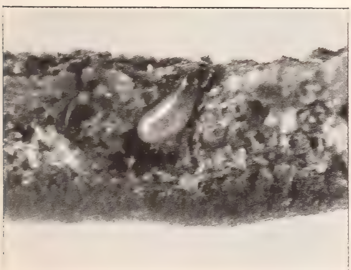

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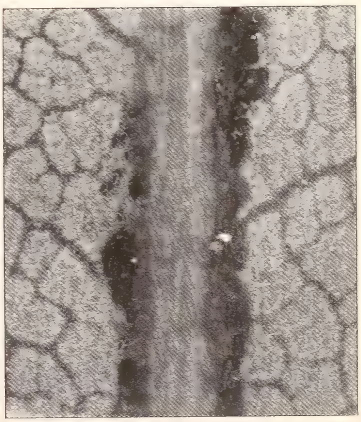

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Rhododendron Lace Bug

THE IMMATURE STAGES OF THE BLACK APPLE LEAF-HOPPER (IDIOCERUS PROVANCHERI VAN DUZEE)[1]

By M. D. Leonard, *Ithaca, N. Y.*

During the past five or six seasons small blackish homopterous nymphs have been observed on apple twigs brought into the Cornell Insectary during March and April for the purpose of rearing apple red bugs. These nymphs have also been seen during the spring and early summer in large numbers on the leaves of many apple trees about Ithaca, N. Y. It was not, however, until the spring of 1914 that an adult of this species was obtained when it was found to be *Idiocerus provancheri* Van Duzee.

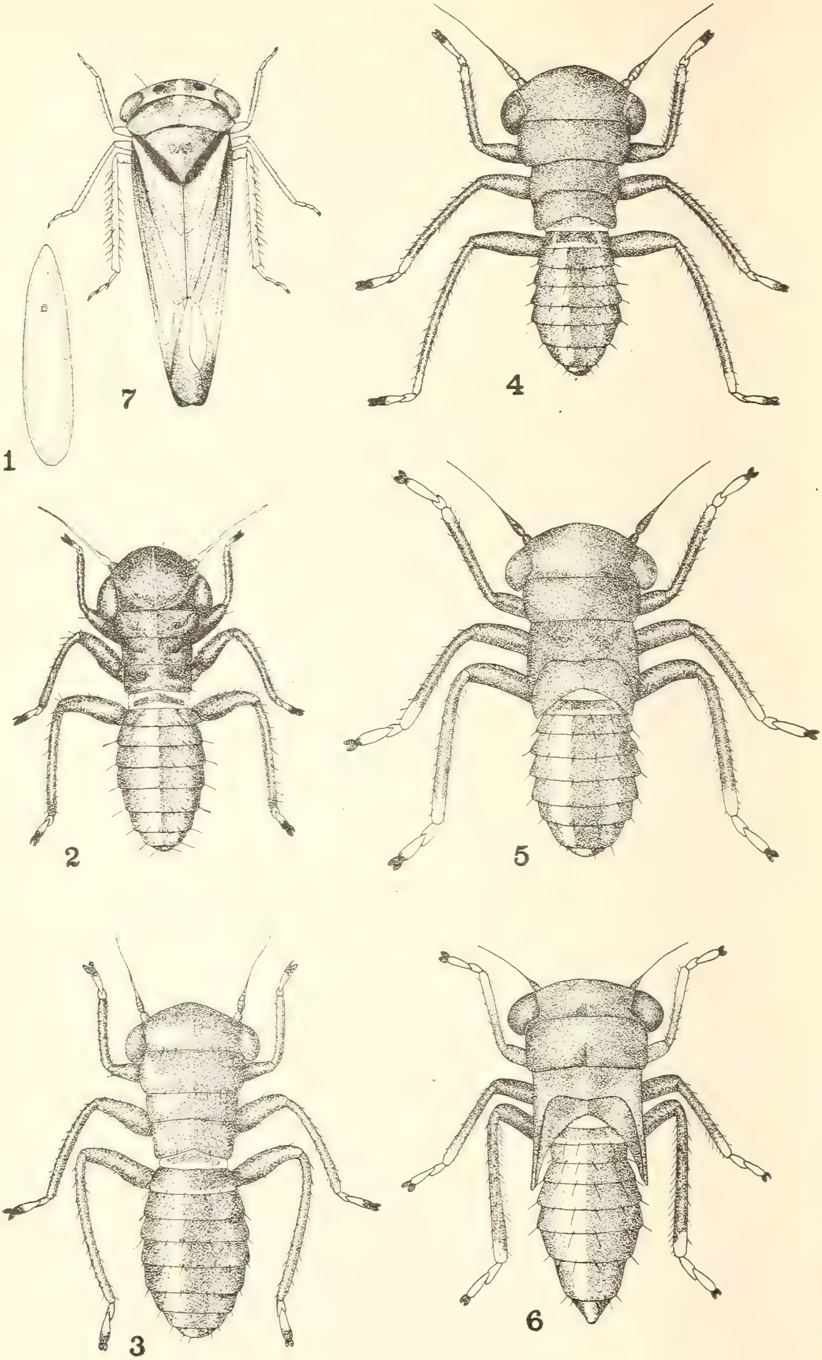
Osborn & Ball (1898: 124–125) state that the species of *Idiocerus* of which the life histories are known are confined to the different species of *Salix, Populus* and *Cratægus*. *Idiocerus provancheri* has been reared abundantly from apple and the nymphs have been found on quince and on pear. It is also stated that the adults of this genus hibernate and deposit eggs in the spring and that the nymphs "usually mimic the color of some part of the tree upon which they feed and are difficult to detect." *I. provancheri* winters in the egg stage. Moreover, the black nymphs are very conspicuous on the apple foliage and twigs and are not protectively colored. They do, however, have a strong resemblance to a small Attid spider. These facts constitute interesting exceptions to the above statements of Osborn & Ball in regard to members of this genus.

The nymphs feed chiefly on the under side of the leaves and when disturbed are very active dodging about on the leaf or running rapidly along the stem. The effect of the feeding of the nymphs on the leaves is a yellow stippling similar to that caused by the apple leaf hopper.

Idiocerus provancheri has been reared on apple twigs received from Oswego and Newark in New York, from Ridgewood, N. J., and Philadelphia, Pa. Nymphs have been observed on apple trees by Professor C. R. Crosby at Stuyvesant Falls, Williamson, Spencerport, Holley and Penn Yan in New York, by Mr. H. H. Knight at Batavia, N. Y., by Mr. C. B. Savage at Kinderhook, N. Y., by Dr. Robert Matheson at Wolcott, N. Y., and by the writer at Honeoye Falls and Rochester Junction, N. Y. They have been received from Babylon, Long Island, N. Y. Nymphs have also been seen by Professor Crosby on pear at Stuyvesant Falls and by the writer at Oswego, N. Y.

The seasonal life history has not been worked out but nymphs which had recently hatched were observed in abundance at Stuyvesant Falls,

[1] Contribution from the Department of Entomology of Cornell University.



Black Apple Leaf Hopper

N. Y., on April 29, 1915, and the writer observed nymphs hatching on apple on May 6, 1915, at Ithaca. Hatching apparently commences at about the time the blossom clusters appear. At Rochester Junction a number of nymphs were observed on June 4, 1914, on an apple tree, one of which was in the third instar. On June 10 an adult was taken from the same tree with the last nymphal skin next to it.

This species has been recorded from Montreal, Winnipeg, and Hamilton in Canada, from Mt. Washington, from Buffalo, Lake Placid and Severance in New York, and is said to occur westward as far as Iowa. The two specimens which represent this species in the Cornell University collection were collected by E. P. Van Duzee in 1886 at Lancaster, N. Y.

The eggs of this species, according to the observations of Professor Crosby, are inserted almost full length into the bark of the fruit spurs about one-fourth inch from the base of the buds. The exuvium protrudes slightly. These were observed commonly by him on apple trees at Stuyvesant Falls, N. Y., on April 29, 1915. Newly hatched nymphs were abundant on the twigs. The writer has observed small hemipterous eggs inserted almost full length into the bark just at the base of the fruit buds on an apple tree near the Insectary at Ithaca. First stage nymphs of *Idiocerus provancheri* were present on the tree. One of these eggs was dissected out of the twig and it bore so strong a resemblance to the egg of *Idiocerus alternatus* Fitch, as figured by Osborn & Ball in the paper referred to above, that I think there is no doubt of its belonging to the species under consideration. This egg is shown in Plate No. 24, figure 1.

The following descriptions of the immature stages of this species are based upon rearings made in the Cornell Insectary during the past two seasons.

The egg.—Length, 1.62 mm., greatest width, .45 mm., cylindrical, slightly curved, broader and more bluntly rounded at posterior end, tapering somewhat at anterior end and acutely rounded; pale yellowish or whitish in color, somewhat shining. In the figure the eye-spot of the embryo is shown.

Stage I (*Pl.* 24, fig. 2).—Length, 1.12 mm.; width of head including the eyes, .56 mm.; abdomen at widest point, .32 mm. General color, shining dark brownish to black. First segment of abdomen pale yellowish with a broad slightly procurved dark

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Explanation of Plate 24

Idiocerus provancheri V. Duz.

Fig. 1. Egg.
Fig. 2. First stage nymph.
Fig. 3. Second stage nymph.
Fig. 4. Third stage nymph.
Fig. 5. Fourth stage nymph.
Fig. 6. Fifth stage nymph.
Fig. 7. Adult.

brownish band which does not touch the lateral margins. Second segment sometimes pale yellowish near median portion. Eyes dark reddish; antennæ with the basal segment black, otherwise pale yellowish. Legs shining blackish; coxæ, trochanters and tarsi pale yellowish, except the tip and claws.

Stage II (Pl. 24, fig. 3).—Length, 1.68 mm.; width of head including eyes .72 mm. Differs from preceding stage only in size, in that the head is not proportionately so large or abdomen so narrow and hind margin of metathorax is somewhat procurved.

Stage III (Pl. 24, fig. 4).—Length, 2.4 mm.; width of head including eyes .975 mm.; width of abdomen, .75 mm. General color blackish; whole dorsal surface and legs finely punctate so that it is not so shiny as in the two preceding stages. Antennæ dark, eyes dark reddish. Tibiæ at tip, and tarsi, except at tip, pale yellowish. First abdominal segment almost entirely pale yellowish, second pale yellowish on hind margin and towards lateral margins. Wing-pads slightly apparent.

Stage IV (Pl. 24, fig. 5).—Length, 3.1 mm.; width of head including eyes, 1.2 mm.; width of abdomen .9 mm. As in preceding stage but legs have a tendency to be brownish rather than blackish; femora at base, tibiæ at tip and tarsi except extreme tip, and the claws, pale yellowish; femora above light brownish towards tip. The whole of the first abdominal segment and the hind margin and an oblique streak near each lateral margin of second, pale yellowish. Metathoracic wing-pads reach backward to about second half of third abdominal segment and mesothoracic wing-pads almost as far.

Stage V (Pl. 24, fig. 6).—Length, 4.3 mm.; width of head, including eyes 1.5 mm. As in preceding stage except that tibiæ are lighter, the terminal half of the fore tibiæ pale yellowish; the wing-pads reach back to fifth abdominal segment and the head and thorax are sparsely sprinkled with fine, short, pale hairs.

In all of the stages, when actively feeding, the abdomen of the nymphs may frequently become distended with food so that the intersegmental areas show as red bands between the segments.

Adult (Pl. 24, fig. 7).—This species is described by Osborn & Ball (1898) as follows: "Fulvous brown, resembling *maculipennis*, but with a broad yellow stripe on the clavus. Length, ♀ 5.3 mm.; ♂ 5 mm.; width, 1.7 mm. Face as in *maculipennis* in both sexes, pronotum lacking the black spots and the light margin, the two outer spots smaller, the middle one elongate; scutellum entirely rufous, darker in the male. Elytra fulvous brown, the nervures indistinct, scutellar margin black; just outside this to the margin of the clavus and extending back to just before the apex of the outer claval nervure where it rounds off is a distinct bright yellow area; costal margin with a hyaline spot before the tip.

"Structurally very close to *maculipennis*, slightly smaller, readily distinguished by the bright yellow clavus."

Some of the specimens which I have before me have the pronotum and scutellum black, except for a small median spot at the cephalic border of the former and for the caudal border of the latter, which are yellow. The face is yellow with three black stripes, one median and one extending from each eye to the base of the beak.

Following Osborn and Ball I have used, in this paper, the name *Idiocerus provancheri* Van Duzee, although I am not convinced that this is the correct name to apply to the species under discussion. This insect was first described by Provancher in 1890 under the name *Bythoscopus clitellarius*, which he erroneously ascribed to Fitch, giv-

ing as a reference: Third Rept. Inj. Ins. N. Y., p. 365, No. 69. In this place Fitch merely briefly described, and recorded the injury to plum by, *Bythoscopus clitellarius* Say, using that name. In 1890 Van Duzee proposed a new name, *provancheri*, for Provancher's species on the ground that the latter's name was invalid because the species considered by Fitch was *Thamnotettix clitellarius* Say. I do not see why this fact should invalidate Provancher's name, *clitellarius*. The insect under consideration was first described by him under this specific name and since the name *clitellarius* had not been used before in the genus *Idiocerus* there is no reason why the species should not be called *Idiocerus clitellarius* Provancher. In order to avoid confusion, since the insect is well known under its present specific name, I have not made the above change in the present paper.

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LITTLE-KNOWN WESTERN PLANT-LICE. I

By W. M. DAVIDSON, *Scientific Assistant, Deciduous Fruit Insect Investigations, Bureau of Entomology*[1]

Phylloxera salicola Pergande

Phylloxera salicola Pergande; Pergande, North American Phylloxerinæ Affecting Hicoria (Carya) and Other Trees. *Trans. Davenport Acad. Sci.*, IX.

This species occurs in California on willow (*Salix lasiolepis* Benth.). The infestations are mostly confined to the axils of the buds on the twigs, but in one instance a heavy infestation occurred on the bared roots of a willow growing on a stream bank. These roots were about half an inch in diameter. The lice occurred in small cracks of

[1] Published with the permission of the Chief of the Bureau of Entomology.

the bark and so numerous were they that the roots appeared to be covered with a thin layer of cottonwool. All examinations failed to disclose nymphs or winged forms. Pergande states that some of the eggs deposited by the apterous adults were sexual. I failed to find any sexual lice and it is likely that in California the asexual generations proceed to reproduce throughout the winter as is the case with many other species. Dates of observation were November 6, 1913, February 3, 1914, October 15, 1914. On all these dates the colonies comprised eggs and lice in all instars. Collected at Walnut Creek, California.

Phylloxera popularia Pergande

Phylloxera popularia Pergande; Pergande, North American Phylloxerinæ Affecting Hicoria (Carya) and Other Trees. *Trans. Davenport Acad. Sci.*, IX.

Infests the limbs and twigs of *Populus trichocarpa* T. & G. and *P. fremontii* Wats. The individuals are covered with a white cottony substance and are usually to be found in cracks or clefts in the bark where they obtain food from the inner layers. They also invade old galls of *Thecabius populicaulis* Fitch. Specimens collected April 20 and May 4, 1914, at Walnut Creek, California

Thecabius populicaulis Fitch

Pemphigus populicaulis Fitch; Fitch, *Rept. Ins. N. Y.*, V, 1859.

In the latitude of San Francisco I have observed the sexuparæ under poplar bark (*Populus fremontii* Wats.) in late winter and spring. Some were found alive and depositing sexes as late as May 12.

The sexes appear to cast four molts, all in rapid succession, and immediately after the final molt they copulate and the single egg is laid in a crevice in the bark, on trunk or larger limbs or any dead plant matter that may be touching the tree. The female is pale orange, beakless, and when gravid measures about .86 mm. x .38 mm. and after the egg has been laid but .44 mm. x .36 mm. The male is darker and narrower, also beakless, and measures about .60 mm. x .25 mm. The females are much more abundant than the males. After the female has deposited the egg she remains active for a short period, much shrunken and brown. A day before the deposition of the egg, cottony filaments are excreted by the female and she contrives to cover the egg with these. Incubation in May takes about two weeks. The egg at first is yellowish-green, but before it hatches the color becomes apple green. The egg is about half a millimeter in length and about half as wide. The fundatrix after hatching is apple green with black transverse bars on the dorsum. For a few days (in April and May) it remains close by the empty egg-shell under the protection of the bark of the tree. Later it ascends the tree and seeks a young leaf

Section of willow root exposed to light under stream bank and infested by *Phylloxera salicola* Perg.

at the base of which to settle. After a few days the petiole begins to swell at the point of attack and the gall gradually proceeds to form about the growing louse. If the wrong species of poplar is selected by the sexuparæ for depositing the sexes, the fundatrix will hatch from the winter egg but will not feed successfully on the foliage and finally will die without having shown any appreciable growth.

I have bred a Syrphus fly (*Pipiza pisticoides* Will.) from a larva found feeding upon the sexuals of this aphid.

The winged spring migrants (funditrigenia) in the latitude of San Francisco may be found in the galls from May to November. The alternate host-plant is as yet unknown to me.

Prociphilus fraxini-dipetalæ Essig

Pemphigus fraxini-dipetalæ Essig; Essig, Pomona College Journal of Entomology, III, 3, Sept. 1911.

What I am inclined to consider as the sexuparæ of this species were taken under the bark of ash (*Fraxinus oregana*) March 16, 1915. On that date the sexuparæ were all dead and dried up and nearly all the winter eggs had hatched. The young reddish stem-mothers occurred higher up on the tree either in cracks of the limbs or on the expanding foliage and excreted much cottony substance. On March 26, many of these stem-mothers were mature and were undoubtedly *Prociphilus fraxini-dipetalæ*, so that it would appear reasonably certain that the dead sexuparous migrants below were of this species in spite of the marked difference in antennal characters between them and the winged spring migrant. This difference in antennal structure between spring migrants and fall migrants is very noticeable among the Pemphiginæ. The spring migrants of *P. fraxini-dipetalæ* have been taken both on ash and olive and occur almost all over California. They have joints III and IV of the antennæ sensoriated while the fall migrants from ash bark have all 4 of the principal antennal joints with sensoria. From the dried up specimens of sexuparæ the following notes were taken: Costal and subcostal veins black, prominent; other veins with rather indistinct light brown smoky borders. Legs black. Thoracic wax glands as in Prociphilus. Antennæ III, .37 to .42 mm.; sensoria 14 to 17; IV, .18 to .27 mm.; sensoria 5 to 11; V, .19 to .23 mm.; sensoria 6 to 7; VI, .18 to .20 mm. (unguis .04 besides); sensoria 5 to 6. Length of wings about 4 mm. Place of collection, Walnut Creek, Cal.

This species may perhaps prove synonymous with *Prociphilus venafuscus* Patch.

Euceraphis gillettei sp. nov.

Winged viviparous female.—General color pale apple green. The majority of individuals are quite bare but some of those of the later generations secrete a scanty amount of greyish-white flocculence. Antennæ much longer than the body, on frontal

tubercles which are large and slightly gibbous. The basal joint is also slightly gibbous. The antennæ are pale green in color with the articulations of joints III and IV, apical third of V, apical half of VI, and filament, blackish. Sensoria of joint III number 13 to 17. They are on basal third, are transverse oval, elongate, and not placed so closely together as in *E. betulæ* Kalt. Filament of VI about three-quarters as long as the joint. Eyes red. Ocelli rather large. Thoracic lobes and scutellum light greenish-brown. Wings rather narrow; stigma long and narrow; stigmatic vein deeply curved; veins not as dark as in *betulæ*. Legs pale green; knees, tarsi and tibial apices black or dusky. Anterior margin of femora with a row of brownish spots, often coa-

MEASUREMENTS

	Length of body	Width of body	Wing expanse	Hind tibia	Beak	Cor-nicles	Cauda	
1. Stem-mother; Walnut Creek, Cal. *Alnus rhombifolia*, March 23, 1915.	2.50	.74		2.55 2.52	.53	.106 .106	.22	
2. Stem-mother; Walnut Creek, Cal. *Alnus rhombifolia*, March 23, 1915.	2.51		9.24		.60	.141 .140		
3. Second generation; Walnut Creek, Cal. *Alnus rhombifolia*, April 24, 1913.	2.45	.83	8.70	2.79	.62	.140 .131	.22	
4. Second generation; Walnut Creek, Cal. *Alnus rhombifolia*, April 24, 1913.								
5. Second (?) generation; San José, Cal. *Alnus rhombifolia*, May 5, 1912.	3.64	.93	9.61	3.26 3.46	.68	.136 .136	.22	
6. Generation (?); Colorado. *Betula fontinalis*, August 1, 1909 (C. P Gillette).			9.33	3.01 3.05	.67	.157 .136	.21	

ANTENNÆ

	I	II	III	IV	V	VI	Fila-ment	Sensoria (III)
1.	.19 .18	.09 .09	1.37 1.34	.76 .73	.66 .63	.30 .30	.17 .18	16 15
3.	.25 .25	.11 .11	1.71 1.74	.96 .98	.80 .84	.34	.22	15 15
4.			1.72 1.67	.96 .97	.84 .87	.34 .34	.20 .20	14 15
5.	.24 .26	.105 .105	1.74 1.71	1.27 1.27	1.03 1.01	.41 .43	.31 .30	16 13
6.	.23 .24	.11 .11	1.71 1.71	1.16 1.16	.97 .99	.41 .41	.30 .31	17 16

lescing. Basal third of tibiæ with brown or blackish margins. Abdomen narrow without markings. Cornicles a little longer than wide, slightly constricted in the centre, the apex flaring and slightly oblique to the somewhat enlarged base. Cauda globular, longer than the cornicles, constricted in the centre. Cornicles and cauda concolorous with the abdomen. Anal plate indistinctly emarginate. Cauda and anal plate thickly beset with spines. Beak pale green, tip black, reaching almost to the second pair of coxæ. Short hairs occur on antennæ, head and legs. On the sides of some of my specimens on the three basal abdominal segments occurs a pair of indistinct pale blunt tubercles surmounted by a spine. The stem-mothers are winged and their appendages are relatively shorter than those of later generations.

Pupa.—Similar in color to the winged female. Tarsi and articulations of antennal joints black. Long capitate spines occur all over the body in rows. Three mature specimens measure respectively 2.96 x 1.22 mm., 3.20 x 1.34 mm., 3.14 x .96 mm.

A narrow elongate species occurring in California on the under side of the leaves of *Alnus rhombifolia* Nutt., and in Colorado on *Betula fontinalis* and *Alnus sp.* For the Colorado specimens I am indebted to Prof. C. P. Gillette who figured the antenna of this species in JOURNAL OF ECONOMIC ENTOMOLOGY, August 1910, p. 370, under the name of *Euceraphis* sp.

Eucallipterus flavus Davidson

Euceraphis flava Davidson; JOURNAL ECON. ENT., Vol. V, No. 5, Oct. 12.

Oviparous female.—General color pale yellowish white. The individuals are sometimes slightly woolly but more often bare. There is a patch of silvery flocculence on either side below the cornicles. The thorax and abdomen bear four longitudinal rows of dusky subquadrate areas and of these the two central ones on abdominal segments 4–8 inclusive are generally coalesced so as to form 5 rectangular areas. Antennæ on small frontal tubercles, longer than the body, pale with the articulations blackish. Joint VI is slightly longer than its filament. Cornicles black, much widened basally, .12 mm. long and constricted in the centre. Cauda pale yellow, globular, heavily beset with spines. Legs pale, the tarsi dusky. Hind tibia very slightly enlarged, sensoriated. Anal plate not bifurcid, beset with spines. Beak pale with the tip dusky, reaching a little beyond the second coxal pair. There are 6 rows of indistinctly capitate spines down the thorax and abdomen. The eighth abdominal segment bears on its posterior margin 18 spines.

Collected in October 1913 and 1914 near Walnut Creek, Cal., on leaves of *Alnus rhombifolia* Nutt.

The oviparous female is very elongate and appears to be quite prolific as I have an example in the abdomen of which are 15 eggs of mature size. The eggs are laid in small groups at the axils of the new buds on the twigs or canes. They are sparsely clothed with silvery flocculence in the same manner as pertains in the Mealy Plum-louse (*Hyalopterus arundinis* Fab.).

Male.—General color pale whitish-yellow. This form like the winged viviparous female is coated with a gray or bluish-gray flocculence. Antennal annulations dusky. Antennæ on large frontal tubercles, much longer than the body, the relative length of the joints as in the oviparous female. Third joint with a large number of oval

transverse sensoria. Prothorax bears 2 longitudinal dusky bands. Thoracic lobes and scutellum black. On abdominal segments 2, 3, 4 and 7 occur on each a pair of dusky blunt tubercles on the sides. Cornicles dusky, much widened basally and constricted in the centre. Tarsi and apex of tibiæ black, rest of legs pale. Wings large, second fork of third discoidal midway between first fork and wing apex. Cauda and anal plate pale, former globular and beset heavily with spines, latter emarginate. Apical margin of seventh abdominal segment dusky. Beak as in the oviparous female.

The male is immediately recognizable from the winged viviparous female both by its smaller size and by the noticeable black thoracic lobes. During October 1914, the sexes predominated over the agamous forms and in the first half of November oviposition was in progress.

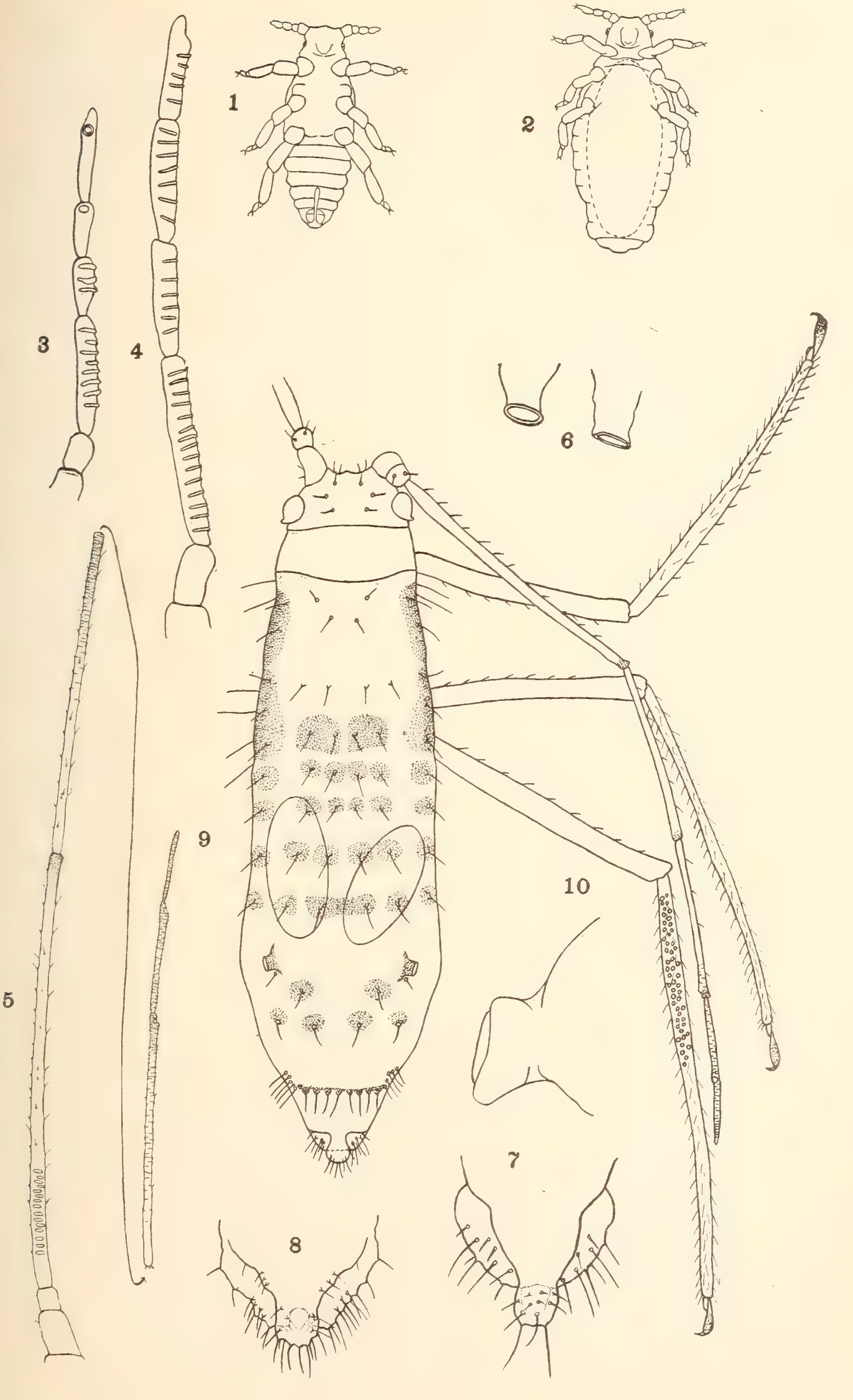
MEASUREMENTS

Oviparous female	Male	
2.70	2.37	Length of body
.94	.70	Width of body (max.)
	7.69	Wing expanse
.120	.09	Cornicles (length)
.125	.13	Cornicles (width at base)
.11	.11	Cauda (length)
.13	.12	I—Antennæ
.09	.09	II
1.05	1.35	III
.69	.99	IV
.60	.76	V
.33	.44	VI
.26	.32	Filament
1.71	2.39	Hind tibia

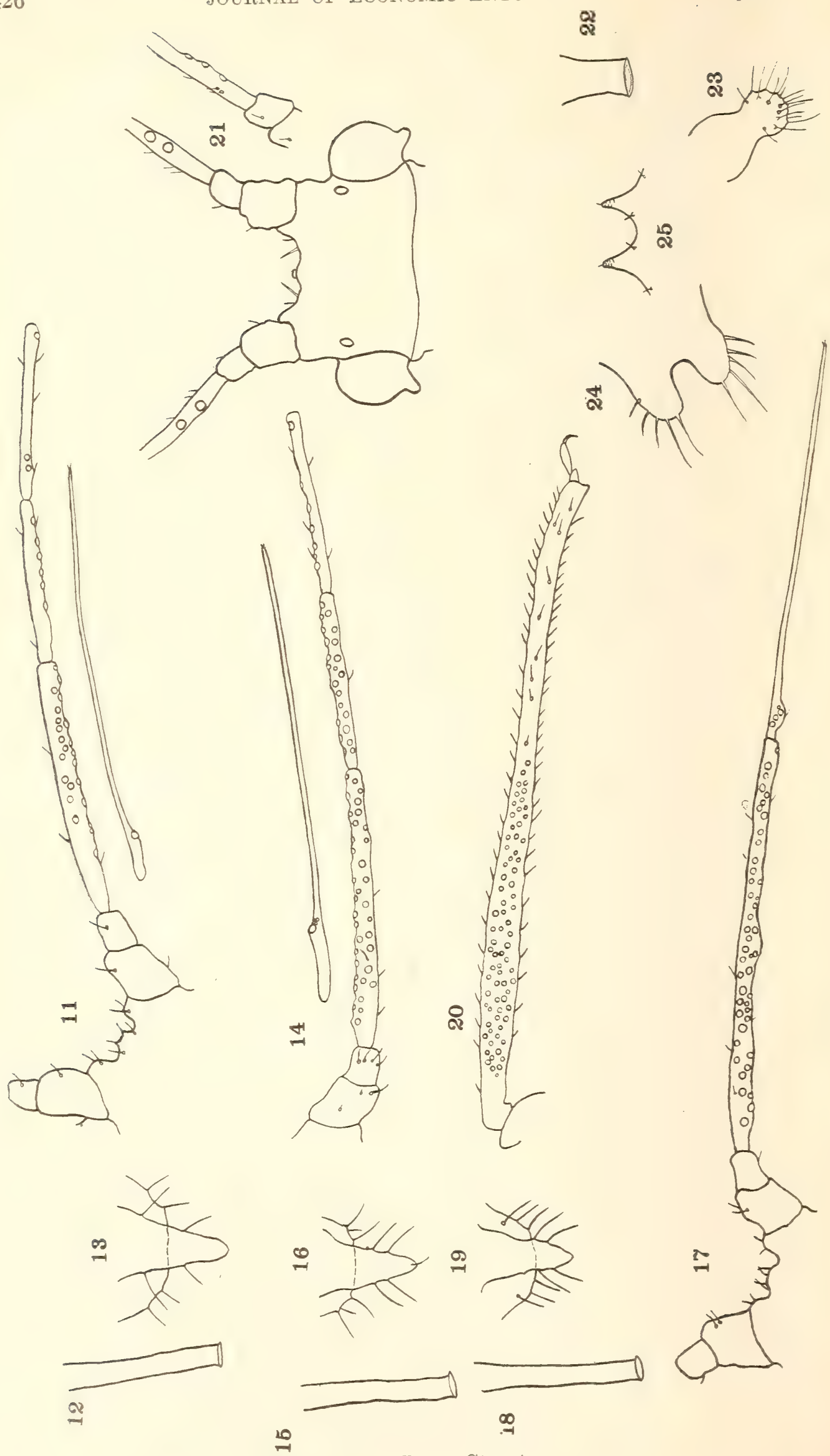
According to Professor Wilson's key of the Callipterini (*Can. Ent.*, XLII, 8, August 1910), this species runs either to Euceraphis Walker, or to Eucallipterus Schouteden. The broadened base of the cornicles and the cleft anal plate are indications of the latter genus, while the strong frontal tubercles and the lack of auxiliary ocellus-like tubercles on the forehead appear to indicate the former. On the whole I am inclined to place the species in the genus Eucallipterus.

Myzocallis pasaniæ sp. nov.

Winged viviparous female.—General color pale green mottled with patches of darker green. Antennæ slightly longer than the body, fine, hyaline, situated on moderate-sized frontal tubercles; articulations black. Joint III bears on its enlarged basal sixth 2 or 3 circular sensoria. Joint I, slightly gibbous on its inner side. Eyes dark red. Thoracic lobes and scutellum greenish-brown. Legs very pale green, extreme base of all tibiæ and tarsi wholly black. Stigma pale green; at the base and apex are ill-defined brown areas. Immediate bases of first and second discoidal and of stigmatic vein clouded briefly brownish. Stigmatic vein visible for its entire length. Mesothorax bears a pair of short conical tubercles. On abdominal segments 1 and 2 occur on each a pair of hyaline acutely conical tubercles, all four of which bear 3 spines.



Western Plant Louse Structures



Western Plant Louse Structures

Smaller and more blunt tubercles occur on the sides of segments 3 to 6 inclusive, but these are not very obvious. Cornicles hyaline, almost twice as long as broad, somewhat constricted in the centre. Cauda globular, pale green, longer than the cornicles and thickly beset with bristles. Anal plate deeply cleft, spinous, pale green. Beak pale, extreme tip brown, almost reaching the second pair of coxae.

The three pairs of dorsal tubercles in living specimens appear white. The two abdominal pairs are about three times as long as the mesothoracic pair and of them the pair on the second segment is the longer. In living examples the whole body has many delicate pruinose markings. The areas of darker green occur mostly about the base and along the sides of the abdomen.

The insect is noticeably narrow-bodied and occurs on the under side of the leaves of tan-bark oak (*Pasania densiflora* Oerst.). The pupa is of the same color as the winged female, but is shorter and more robust. Dates of collection and localities for the winged viviparous female are as follows: Berkeley, Cal., June 12, 1914; Congress Springs, Cal., November 6, 1914; Berkeley, Cal., February 17, 1915. The tan-bark oak is an evergreen tree.

Measurements; Length of body, 2.04 mm. to 2.60 mm. Max. width of body, .73 mm., to .97 mm. Cornicles, .09 to .12 mm. Cauda, .17 to .19 mm. Wing expanse, 5.7 mm. Antennæ I, .078 mm.; II, .05 mm.; III, .72 to .87 mm.; IV, .60 to .70 mm.; V, .53 to .59 mm.; VI, .26 to .29 mm. Filament, .29 to .31 mm.

Macrosiphum heucheræ Thomas

Siphonophora heucheræ Thos. Thomas, 8th Rept. Ill., Nox. Ben. Ins., 1880.

Apterous viviparous female.—General color dark reddish-brown. Eyes red. Antennæ and cornicles black. Cauda reddish-brown. Legs black, basal third of femora and median portion of tibiæ reddish-brown. Antennæ about equal to the body in length, on slightly gibbous frontal tubercles. Filament of VI longer than III; IV and V subequal. Cornicles cylindrical, imbricate but not reticulate. Cauda ensiform, twice as long as broad at base. Body sparsely armed with short hairs. Sensoria circular tuberculate, about 26 on III, 7 on IV, 2 beside usual apical on V. One specimen has the joints III to V inclusive all fused together. Measurements: Length, 2.13 mm. Max. width (3d. abd. seg.), 1.00 mm. Hind tibia, 1.64 mm. Cornicles, .34 mm. to .40 mm. Cauda, .233 mm. Beak, .58 mm. Antennæ III, .53 mm.; IV, .355 mm.; V, .355 mm.; VI, .12 mm. Filament, .70 mm. Beak reaches beyond second coxæ.

Winged viviparous female. General color dark green. Wing insertions and ill-defined spots on the sides of the abdomen brick-red. Disk of abdomen with a large dusky spot. Head, thorax and cornicles black. Antennæ black, base of III green. Cauda reddish-brown. Eyes dark red. Stigma gray, long and narrow. Legs black, basal fourth of femora and tibiæ except the apex pale greenish-yellow. Antennæ on frontal tubercles a little exceeding the body in length, filament longer than III, IV and V subequal. Cornicles cylindrical. Cauda ensiform. Beak reaching to middle coxæ. Sensoria circular tuberculate, about 39 to III, 22 on IV, 7 on V. One specimen has the antennal joints III, IV, V fused together so that the articulations are not discernible. Measurements: Length, 2.18 mm. Max. width (thorax) .83

mm. Expanse of wings, 7.00 mm. Hind tibia 1.64 mm. Cornicles, .30 mm. Cauda, .19 mm. Beak, .56 mm. Antennæ III, .58 mm.; IV, .37 mm.; V, .365; VI, .125 mm. Filament, .81 mm.

The newly-hatched young are pale yellow.

Oviparous female.—Wingless, general color light red. Legs and cornicles dusky yellowish-gray. Cauda pale yellowish-gray, shaped as in viviparous forms. Antennæ dusky gray, joints I and II and base of III pale yellow, on slightly gibbous frontal tubercles. Joint I slightly gibbous on inner surface. Eyes dark red. Body sparsely armed with short pale hairs. Anal plate rounded, hairy. Hind tibiæ somewhat swollen for their basal two-fifths and bearing in that portion numerous small circular sensoria. Cornicles imbricate. Sensoria of antennæ circular tuberculate, about 20 on III, 4 to 11 on IV, usual apical on V. While the female is egg-laying she becomes darker in color and old examples are quite reddish-brown like the apterous vivipara. Measurements: Length, 1.56 mm. to 2.04 mm. Max. width (3d abd. seg.), .93 mm. Hind tibia, 1.28 mm. Cornicles, .31 mm. Cauda, .17 mm. Beak, .545 mm. Antennæ III, .35 mm. to .43 mm., IV, .21 mm. to .29 mm.; V, .215 mm. to .245 mm.; VI, .07 mm. to .12 mm. Filament, .533 to .763 mm. (The measurements for length of body and antennal joints give variation between largest and smallest examples; the other measurements are averages.)

The "winter" eggs I have found laid on the flower-stalks of *Heuchera hartwegii* Dougl. They are at first pale yellow, later becoming jet black, shining. They were being deposited May 25, 1914.

Male.—Winged, general color variable, dark reddish-brown to dark green. Much black is on the disk of the abdomen. Head, thorax and antennæ (except base of III) black. Legs with more pale color than in the winged vivipara. Otherwise like the winged female but smaller. Antennæ on somewhat gibbous frontal tubercles, much longer than the body, filament relatively longer than in the other forms. As in the winged female, the second fork of third discoidal vein is slightly nearer to the apex of the wing than to the first fork. All tibiæ slightly enlarged apically. Sensoria circular tuberculate, 27 to 38 on III, 12 to 19 on IV, 9 to 13 on V. Beak reaches second coxæ. Measurements: Length, 1.55 mm. Max. width (thorax), .55 mm. Expanse of wings, 5.52 mm. Hind tibia, 1.44 mm. Cornicles, .22 mm. to .27 mm. Cauda, .125 mm. to .156 mm. Beak, .564 mm. Antennæ III, .48 mm. to .61 mm.; IV, .34 mm. to .38 mm.; V, .37 mm. to .385 mm.; VI, .12 mm. to .14 mm. Filament, .85 mm. to .94 mm. (first four measurements average of 4 individuals).

A rather small, long-legged, dark-colored species frequenting the flower stalks of *Heuchera hartwegii* Dougl. All forms were taken May 25, 1914, at Redwood Canyon near Walnut Creek, Cal. Thomas took this species at Sauk City, Wisconsin, on *Heuchera hispida*.

Explanation of Plates 26, 27

1–3. *Thecabius populicaulis*. 1. Male (ventral view). 2. Sexed female (ventral view). 3. Sexupara, antenna.

4. *Prociphilus fraxini-dipetalæ;* Sexupara, antenna.

5–7. *Euceraphis gillettei;* alate viviparous female. 5. Antenna. 6. Cornicle (showing variation). 7. Cauda and anal plate.

8–10. *Eucallipterus flavus*. 8. Alate viviparous female, cauda and anal plate.

9. Oviparous female (left side appendages removed). 10. Oviparous female, cornicle (enlarged).

11–20. *Macrosiphum heucheræ.* 11–13. Apterous viviparous female. 11. Head and antenna. 12. Cornicle. 13. Cauda and anal plate. 14–16. Alate viviparous female. 14. Antenna. 15. Cornicle. 16. Cauda and anal plate. 17–20. Oviparous female. 17. Head and antenna (showing abnormal coalescence of joints III–V). 18. Cornicle. 19. Cauda and anal plate. 20. Hind tibia.

21–25. *Myzocallis pasaniæ.* 21. Head and base of antenna. 22. Cornicle. 23. Cauda. 24. Anal plate. 25. Pair of tubercles on first abdominal segment.

Figs. 1, 2. Eyepiece 2, obj. $^2/_3$ (tube drawn out to 160).

Figs. 5, 9. Eyepiece 2, obj. $^2/_3$.

Figs. 21–25. Eyepiece 1, obj. $^2/_3$ (tube drawn out to 170).

Figs. 3, 4, 6, 7, 8, 11–20. Eyepiece 1, obj. $^2/_3$.

Fig. 10. Eyepiece 2, obj. $^1/_6$.

Scientific Notes

Cotton Moth (*Alabama argillacea* Hubn.). The moths were observed in Kent, Ohio, in large numbers September 23, 1914, following several days of warm weather with a strong south wind. This weather condition was produced by a high area that hung over the central Atlantic coast for some time, causing the storms to be deflected to the north through Canada instead of following their usual course. The moths were so abundant on this date, the time of their initial appearance for the season, as to almost cover portions of telegraph poles upon which they were resting.

Smaller flights were observed on two or three other nights though the dates were not recorded except that for October 16, a time when weather conditions were similar to those described for September 23. On each of the other occasions, the moths appeared after a period of south winds.

The flight at Kent, Ohio, was nowhere near as abundant as one observed at Batavia, N. Y., during the fall of 1912 and indirectly recorded through an article published in the local paper. R. W. Braucher.

The Cabbage Curculio (*Ceutorhynchus rapæ* Gyll.) **Injuring Radishes.** During the last two weeks of April a number of reports reached the department of entomology of a small snout beetle seriously injuring radishes. Several of the inquiries were accompanied by the insects. On other occasions the injury was investigated by men of the department. In most of the instances it proved to be the cabbage curculio (*Ceutorhynchus rapæ*). On some occasions as many as a dozen beetles were found around the stem of a single plant, and in several cases they were found feeding on the root an inch beneath the surface of the soil. The beetles were taken in several gardens from Manhattan on east as far as Kansas City. They were also found at Atchson, Kansas. In many cases the early radishes were completely destroyed.

Geo. A. Dean,
Entomologist, Kansas Experiment Station.

Radishes Seriously Injured by Flea Beetles. Over a considerable portion of the eastern third of Kansas, the early radishes were very seriously injured by the striped turnip flea-beetle (*Phyllotreta vittata* Fab.) and the western cabbage flea-beetle (*Phyllotreta pusilla* Horn). In many instances they appeared in unusually large numbers and the radishes were entirely destroyed within one or two days. In most cases the turnip flea-beetle was more abundant than the other. The work of both species was confined principally to the succulent stem just at the surface of the ground, causing the leaves to dry up and die. In some cases they also fed on the leaves, especially where the plants were an inch or more in height. Some of the truck growers report that the second and even the third plantings were destroyed.

Geo. A. Dean,
Entomologist, Kansas Experiment Station.

Progress on the Manual of Dangerous Foreign Plant Pests. At the Cleveland meeting, December 1912, a resolution was passed by the American Association of Horticultural Inspectors (now a section of this association) "that a publication be issued giving brief illustrated accounts of (1) the various dangerous insect, fungous and other enemies of vegetation liable to be introduced on nursery stock or other plant products, (2) similar pests already present in portions of this country and which may be spread on plant products."

A committee was appointed to take up this matter with the Federal Horticultural Board and this committee reported at the Atlanta meeting, December 1913, that the Bureau of Entomology had undertaken the work at the request of the Federal Horticultural Board.,

The news letter of the Bureau of Entomology for May states that this manual is now rapidly approaching completion. It is intended to serve as a guide for inspectors and field entomologists to the insects liable to be brought into this country on foreign nursery stock. It will surely be welcomed by all engaged in the work of inspecting imported stock and we await its appearance with great interest. W. E. B.

A Breeding Record by Anthrenus verbasci Linn. The following record is of interest because it shows the tenacity of life exhibited by certain insects under adverse conditions. April 4, 1902, two ears of corn infested by this insect were received and placed in a two-quart Mason jar and kept tightly closed. There was no moisture aside from that in the somewhat dried corn. Breeding continued uninterruptedly and at the end of seven years, namely, April, 1909, the bottom of the jar was nearly covered with fine, white, globose particles, apparently starch grains falling from the eaten kernels of corn and a thick mass of the brown larval skins and other débris. An examination of this same jar June 14, 1915, revealed, after some search, one living grub although the insects were distinctly less abundant than six years ago. On this latter date there was a distinctly pungent odor to the contents, somewhat suggestive of acetic acid and a marked increase in the masses of brown, apparently webbed-together exuviæ and other organic débris, some of these having a diameter of over an inch. There was fully a half cupful of powdered corn and corn cob dust. All of the material was returned to the jar and the breeding is being continued without the addition of any moisture. E. P. Felt.

Liquid Excretion by Dræculacephala reticulata. While studying the habits of this Jassid it was noticed that the method of excretion was in some respects quite different from that of the "Sharp Shooters," as described in *Insect Life*, Vol. V, pp. 150–154. In the case of *reticulata*, nymphs of all instars as well as adults excrete the drops of liquid in a similar manner, though the drops are of course smaller in the earlier nymph stages.

These small drops of water-like liquid, voided from the tip of the abdomen, remained poised for an instant, and were then flipped off in whichever direction the tip of the abdomen happened to be pointed. The excretion usually takes place while the insect is feeding, the rate at which the drops form varying considerably. Each drop is cast off with such speed that it is difficult for the eye to follow. When caught on a slide or on cotton they evaporate quite rapidly. Several drops were caught on absorbent cotton on which they retained their original spherical shape. The discharge ceases when the insect is disturbed and there is no indication of an effort to throw it in the direction of the intruder.

At a temperature of 70° F. the drops from three adults, two females and one male, were counted for periods of five minutes. The result was 168 drops for the male and 225 and 281, respectively, for the females. The drops vary slightly, averaging .45 mm. in diameter, so at this rate each individual excretes about 4 cubic mm. per minute. W. H. Larrimer, *Bureau of Entomology,*
Cereal and Forage Insect Investigations, U. S. Department of Agriculture.

A Curious Feeding Habit of Chrysopa rufilabris Burm. Last fall while collecting locally at Lafayette, Indiana, a chrysopid larva was noticed on a leaf of *Cynoglossum officinale* forcing its long slender mandibles through the epidermis into the burrow of a leaf miner. On closer observation it was seen that the larva was energetically bent on impaling the maggot-like leaf miner on its mandibles. The mandibles were thrust into the leaf repeatedly, the insect bending its head and body in all directions as it probed in its efforts to reach the miner. Finally the miner was cornered in its burrow and sucked dry by the larva. A number of similar mined leaves and miners were collected and the adults obtained from them were identified by Dr. J. M. Aldrich of the Bureau of Entomology as *Agromyza jucunda* Vdw. The chrysopid larva was brought into the laboratory and fed on aphids found on cabbage until it reached maturity and spun its cocoon. The adult obtained was very kindly determined as *Chrysopa rufilabris* Burm. by Mr. Nathan Banks.

Daniel G. Tower, M. S., *Scientific Assistant, Bureau of Entomology,* Cereal and Forage Insect Investigations, U. S. Department of Agriculture.

Notes on an Uncommon Blister Beetle. On the afternoon of April 18, 1915, I was inspecting the bloom in a three-year-old plum orchard at my place in Brown County, Indiana, when I discovered that the trees were covered with a blister beetle that was unknown to me.

This form was subsequently taken to my house and identified as *Pomphopœa œnea.* It is listed in Blatchley's Coleoptera of Indiana as being a rare species taken by him in only two counties.

The beetles were eating the entire substance of the flowers of the plum and were more numerous on the Burbank than on any other sort. This perhaps on account of the fact that the Burbank blooms earlier than the varieties with which it was planted.

On one tree over two hundred beetles were counted and their destructive work was incredibly rapid. They would attack a branch loaded with bloom and eat it up before my eyes in the space of a very few minutes. They seemed to eat first the petals of the flower and then rapidly consume all of the flower parts down to the petiole.

I immediately ordered out a spray machine and within an hour after I first noticed the beetles we had sprayed the trees with lead arsenate at the rate of three pounds to fifty gallons of water. An inspection on the morning of April 19 indicated that the spray applied the day before had not seriously inconvenienced the pests. A few dead beetles were found under the trees but their numbers were not noticeably lessened.

We then sprayed the trees again using five pounds of arsenate of lead to fifty gallons of water and we added one pint of Black Leaf 40 to each fifty gallons of the mixture. Twenty-four hours later not a beetle could be found on the trees although there were some dead ones on the ground under the trees.

Not finding many dead beetles leads me to believe that the tobacco acted as a repellant and that the beetles simply moved on to other pastures—although so far I have heard no complaint from my neighbors.

The beetles destroyed the entire crop of Burbank and seriously damaged the bloom on the America and Red June plums.

On the same date that I first observed the beetles on our trees my former chief deputy, Mr. Frank Wallace, found them feeding on the bloom of plum trees (variety not given) in his brother's orchard in Morgan County. This locality is about fifteen miles northwest of my place.

The literature on this pest seems to be very scant and I would like to hear from any one who has had a similar experience to mine.

Benjamin W. Douglass, *Trevlac, Ind.*

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

AUGUST, 1915

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, as far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photoengravings may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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Scientific men and the parties they serve are both coming to recognize more fully the need of studying field conditions and watching the outcome of remedial or control measures. This is one of the encouraging signs of the times and means a more practical turn to economic or applied entomology. Federal and state agencies are so well distributed throughout the country, that an important insect outbreak does not remain undiscovered long. Usually several investigators are in the field before serious damage has been caused. In cases of outbreaks by well-known insects, demonstrators of one kind or another are available to show the farmer just how to fight the pests effectively and in case of necessity they may take the lead. The work of the demonstrator is exceedingly important because entomology becomes economic only in proportion as it is used. The mere possession of adequate knowledge is not sufficient. It must be successfully applied in saving the crop. Directions, though most lucid, are not always correctly interpreted and the advisor usually must bear the blame. On the other hand, successful demonstrations cannot be disputed. The method is open to examination and the practical man finds it relatively easy to check up and ascertain the error, if one exists. Demonstrational agencies have greatly increased in recent years. There are some entomologists who give much time to work of this character. Nursery inspectors are available for this purpose to some extent at least. The recent great development of the farm bureau work has resulted in a large increase in men possessing, in most cases, both scientific training and practical experience. They are peculiarly adapted to serve as intermediaries between the investigator and the agriculturist. They handle the simpler cases with little or no professional assistance and they are coming, on the other hand,

to appreciate the value of the entomologist in solving the more difficult or unusual problems. The demonstrator is a valuable aid to progress though it never should be forgotten that successful demonstration must rest upon a substantial foundation of ascertained facts.

Obituary

Mr. Harry M. Russell of the Bureau of Entomology died at the home of his father, W. C. Russell, at Phoenix, Ariz., June 25. He was born in Bridgeport, Conn., March 30, 1882, was graduated from the Bridgeport High School in 1901, and from the Massachusetts Agricultural College in 1906 with highest honors. He then entered the service of the Bureau of Entomology of the United States Department of Agriculture, as entomological assistant and was assigned to work on truck crop insects under Dr. F. H. Chittenden. He published several papers in this Journal, and in bulletins and circulars of the Bureau, showing the results of his work. He was an active member of this Association and frequently attended its meetings. In 1913 he went to Arizona for his health. In his death his fellow-workers realize that the subject of economic entomology has suffered a distinct loss. A widow and several children survive.

W. E. B.

Observation on Drinking of Rhogas in Confinement. An adult female *Rhogas terminalis* was put in a few drops of water to dissolve feeding-syrup from her tarsi (an unusual matter, as syrup is not used at the Hagerstown, Maryland station, but honey-water, through the vehicle of a piece of saturated sponge). The abdomen of the female was not normally rounded out, but as soon as she touched the water she became absolutely still, and it was at once noticed that she was engaged in drinking. There was a perceptibly regular pulsation of the water for a period of at least five minutes, during which time no member of the female's body moved. At the end of this period she crawled out of the water with the abdomen properly distended.

W. E. Pennington, *Assistant, Bureau of Entomology,*
Cereal and Forage Insect Investigations, U. S. Department of Agriculture.

Current Notes

Conducted by the Associate Editor

Mr. E. A. Vaughan has succeeded G. W. Ells as field assistant in entomology at the Alabama Station.

Mr. T. H. Parks has resigned as field entomologist of the Idaho Station to engage in private work.

According to *Science*, Mr. H. Scott, of Trinity College, Cambridge, has been appointed curator of entomology in the University.

Mr. A. H. Hollinger, assistant in entomology, has been made deputy inspector of nurseries at the Missouri University and Station.

Dr. Frank L. Thomas has been appointed assistant professor of entomology and assistant entomologist at the Alabama College and Station.

Mr. H. J. Reinhard, a recent graduate of the Ohio State University, has been appointed assistant in the nursery inspection work in Iowa.

Professor J. G. Needham has been elected president, and Professor O. A. Johannsen, treasurer, of the Alpha Chapter of Sigma Xi at Cornell University.

Dr. L. O. Howard, Chief of the Bureau of Entomology, planned to visit certain field stations of the bureau during July and August, especially in the far West.

Dr. A. H. McCray, Bureau of Entomology, planned to transfer his work on bee diseases to the Drummond Laboratory about July 1.

Mr. L. P. Rockwood, Bureau of Entomology, has returned to his field station from an investigation of alfalfa insects in the Yakima Valley, Wash.

Mr. J. J. Davis, Bureau of Entomology, has returned from a trip of investigation of Lachnosterna through Wisconsin, northern and southern Michigan.

Mr. W. R. Walton, of the Bureau of Entomology, has investigated an outbreak of chinch bug in western Virginia.

Mr. James A. Hyslop, of the Hagerstown laboratory, Bureau of Entomology, has investigated wireworm outbreaks in New Jersey and New York.

Mr. P. R. Myers, of the Hagerstown station, Bureau of Entomology, has investigated the Hessian fly situation in Pennsylvania.

Mr. W. S. Fisher, Bureau of Entomology, has just returned from Harrisburg, Pa., where he is carrying on investigations of the hickory bark beetle.

Prof. G. W. Herrick, of Cornell University, visited Louisiana during June to inspect the work on the boll weevil and on malaria mosquitoes.

Mr. Max Kisliuk, Jr., has been appointed a temporary field assistant, Bureau of Entomology, and detailed to investigate the house fly at Drummond, Md.

According to *Science*, Joseph Farrigan, mining engineer and entomologist, and at one time a co-worker with C. V. Riley, died at his home in St. Louis, May 9, aged 58 years.

Mr. Harrison E. Smith, of the Springfield, Mass., station of the Bureau of Entomology, has already begun grasshopper investigations in Vermont and New Hampshire.

Mr. T. J. Talbert, extension entomologist at the Kansas Agricultural College, has been appointed extension assistant professor of entomology at the Missouri University and Station.

According to *Science*, Dr. Cornelius Betten has resigned the professorship of biology in Lake Forest College to become secretary of the College of Agriculture in Cornell University.

The investigation of insects affecting shade trees and hardy ornamental shrubs has been assigned by the chief of the Bureau of Entomology to the Forest Insect Investigations branch.

Messrs. S. A. Rohwer and A. B. Gahan of the Bureau of Entomology visited Quebec, Can., Amherst, Mass., and New Haven, Conn., in June to examine specimens in the insect collections there.

Mr. George S. Demuth, Bureau of Entomology, visited Winchester, Va., recently to assist the county agent there in establishing apiaries in two county schools. Interest in beekeeping among farm demonstrators is increasing.

An experimental apiary was started this spring at the Iowa Agricultural Experiment Station at Ames. The work in apiculture at this station is under the immediate charge of Professor C. E. Bartholomew.

According to *Science*, Mr. H. J. Quayle has been promoted to a full professorship of entomology in the citrus experiment station and graduate school of tropical agriculture of the University of California.

Dr. Hermon C. Bumpus, formerly professor of zoölogy in Brown University, and afterwards director of the American Museum of Natural History, was formally installed as president of Tufts College, June 12.

Science, under date of June 4, stated that Professor R. Newstead of the Liverpool School of Tropical Medicine, is in France, prosecuting entomological investigations from the point of view of military sanitation.

Mr. Joseph J. De Gryse was appointed field assistant in the Bureau of Entomology, March 1, and assigned to work at the Falls Church, Va., station. He is assisting Mr. Heinrich in forest Lepidoptera.

Mr. E. W. Rust, Bureau of Entomology, recently returned from a visit to California. In addition to assisting in inspection work for the Federal Horticultural Board, Mr. Rust is devoting considerable time to the unarmored scales.

The following temporary field assistants have been appointed in the Bureau of Entomology and detailed for investigations of tobacco insects: Messrs. J. U. Gilmore, K. B. McKinney, A. D. Bosley, J. E. McMurtrey, and J. D. Smith.

Professor Vernon L. Kellogg, of Stanford University, sailed for Liverpool on May 29 to join the commission for relief in Belgium, and intends to spend the summer there in volunteer work for the commission.

Mr. W. O. Ellis spent the summer in the insectary at the Iowa Agricultural Experiment Station at Ames. After September 15th he will be at the New York State School of Forestry at Syracuse as instructor in Forest Entomology.

Messrs. E. K. Bynum and W. B. Williams have been appointed temporary field assistants in the Bureau of Entomology and detailed for the investigation of the cotton boll weevil.

Mr. A. B. Duckett, scientific assistant, Bureau of Entomology, has just returned from a trip in New Jersey, where he has been investigating insects injurious to strawberries.

Mr. F. R. Cole, scientific assistant, Bureau of Entomology, a graduate of Pomona College, Cal., formerly located at Pasadena, Cal., has been transferred to Washington, D. C.

Dr. C. P. Gillette, director, Agricultural Experiment Station, Fort Collins, Colo., whose name is widely known as a specialist on aphides, leafhoppers, and related groups, has been appointed collaborator of the Bureau of Entomology.

Mr. G. E. Bensel, for several years interested in practical entomology, has been appointed as collaborator of the Bureau of Entomology, engaged in sugar-beet insect investigations, with headquarters at Oxnard, Cal.

Mr. T. D. Urbahns, of the Pasadena field laboratory, Bureau of Entomology, is looking after serious outbreaks of grasshoppers in the San Joaquin and Sacramento Valleys, Cal.

The present spring has witnessed an unusual outbreak of *Galerucella cavicollis*, which has been many times reported from Pennsylvania, New York, West Virginia, Michigan, and elsewhere, and has been especially injurious to cherry as well as peach.

Mr. John B. Gill of the Monticello, Fla., laboratory, Bureau of Entomology, has just completed a tour of investigation of pecan insects, visiting points in Mississippi and Louisiana.

Mr. A. B. Champlain, Bureau of Entomology, has been transferred from the field station at Colorado Springs, Colo., to the station at East Falls Church, Va., where he will continue his studies of beneficial forest Coleoptera.

Mr. Carl Heinrich, Bureau of Entomology, has just returned from a two weeks' tour in New York and Pennsylvania of investigations of the European pine-shoot moth (*Evetria buoliana*) and an outbreak of cankerworms.

Mr. Dwight Isely, Bureau of Entomology, who spent the winter months in Washington for the purpose of making bibliographical records on grape insects, has returned to his field station at North East, Pa., to resume his duties in connection with grape-insect investigations.

Mr. F. B. Milliken and Mr. F. M. Wadley, of the Bureau of Entomology, have found it advisable to remove their headquarters, formerly at Garden City, Kan., and will establish new quarters at Wichita, Kan., where more attention can be given to insects injurious to stored grains, cereals, and other stored products.

The beekeepers of Iowa, Illinois and Missouri will join in holding a field meeting, Tuesday, September 7, at the Dadant apiaries, Hamilton, Ill. An inspectors' conference will be held the following day, across the river at Keokuk, Iowa, and Mr. Frank C. Pellett, state apiarist of Iowa, will have charge of the program.

Mr. George G. Ainslie, Bureau of Entomology, is investigating various species of Crambidæ, which seem to be doing a great deal of damage in the cornfields the present year, making a trip through the states of Missouri, Kansas, Nebraska, South Dakota, Minnesota, Illinois, and Iowa.

Dr. Henry Fox and Mr. W. T. Emery of the Bureau of Entomology, are away from their field stations at Charlottesville, Va., investigating outbreaks of the southern corn rootworm (*Diabrotica 12-punctata*) and the sugar-cane beetle (*Ligyrus rugiceps*) in southern Virginia.

Mr. C. N. Ainslie, of the Elk Point (S. D.) station, Bureau of Entomology, is on an extended trip through Nebraska and Iowa investigating the peculiar Hessian fly conditions that exist in those localities, coöperating in Iowa with R. L. Webster, entomologist in charge at the Iowa Experiment Station.

Mr. Fred E. Brooks, Bureau of Entomology, has recently returned to his headquarters at French Creek, W. Va., from an extended trip through the South in connection with studies of the distribution and destructiveness of various species of apple-tree borers, especially *Saperda candida.*

Messrs. R. L. Nougaret and W. M. Davidson, of the Walnut Creek laboratory, Bureau of Entomology, in California, will be in attendance at the International Congress of Viticulture, convening in San Francisco in connection with the Panama-Pacific Exposition, and will present a paper on the grape Phylloxera in California.

With the coöperation of Mr. A. F. Burgess, in charge of moth work, an effort is being made to introduce *Calosoma sycophanta* into certain apple-growing regions in the West. It will also be introduced in orchard-growing localities in the Alleghany Mountain region.

An interesting and important addition to the knowledge of the life-history of the brown grape aphid, *Macrosiphum viticola*, was reported in *Science*, Vol. 41, n.s., No. 1066, by Messrs. A. C. Baker and W. F. Turner, Bureau of Entomology. *Viburnum prunifolium* was found to be an alternate food plant on which the insect winters.

Dr. A. D. Hopkins, Bureau of Entomology, has spent about ten days at Kanawha Station, W. Va., in connection with experimental work on insects affecting rustic work, a continuation of life-history studies on trap trees and general field work on forest insects.

Mr. G. A. Runner, Bureau of Entomology, has closed his laboratory at Richmond, Va., and will hereafter be stationed at Clarksville, Tenn. He made a short trip to Schenectady, N. Y., in connection with the tests of X-ray control of the cigarette beetle.

Mr. H. L. Sanford, inspector of the Federal Horticultural Board, recently detected a severe infestation of *Targionia harti* (Ckll.) on yams from the Philippine Islands. This scale insect has also been previously taken on tubers received from the West Indies.

Mr. R. A. Cushman, Bureau of Entomology, who spent the winter months in the National Museum, in systematic work on parasites of deciduous fruit insects, has returned to his headquarters at North East, Pa., to resume his investigations in connection with parasites of the grape berry moth and other parasites of deciduous fruit insects.

Mr. V. L. Wildermuth, Bureau of Entomology, is on a trip of investigation throughout northern Arizona, making observations on the distribution and work of *Chætocnema ectypa* and *Languria mozardi,* the former being quite destructive to corn and other crops, while the latter has been found much more destructive to alfalfa than in the eastern portion of the country. Other insects will also claim his attention.

Mr. H. B. Scammell, Bureau of Entomology, engaged in cranberry insect investigations with headquarters at Pemberton, N. J., reports unusual abundance and injury from the so-called cranberry tipworm, *Dasyneura vaccinii,* in cranberry bogs in that state. Careful biological studies are in progress, as well as experiments with remedies.

Mr. E. H. Siegler, Bureau of Entomology, with headquarters at Grand Junction, Colo., reports very heavy damage to fruit in the Grand Valley by late spring frosts. Orchards have been found, however, with sufficient fruit to permit of experimental spraying for the codling moth, and there is abundant material of this species for life-history studies.

The following temporary field assistants have been appointed in the Bureau of Entomology and detailed for investigations of tobacco insects: Messrs. D. M. DeLong, Charles Hauck, F. C. Liles, Frank G. Sorrels, Oakley M. Shelby, Mack S. Linebaugh, Samuel F. Grubbs, Carl A. Wickland, Richard K. Catlett, and Walter C. Nagle.

A new quarantine inspection house is nearing completion in the Mall near the corner of Twelfth and B Streets N.W., Washington, D. C. In the future all nursery stock addressed to the Department of Agriculture will be delivered to this house for inspection, and, if necessary, will be grown in quarantine in a tightly screened greenhouse constructed for this purpose.

Mr. A. H. Jennings, Bureau of Entomology, who has been in New York City for some months with the Thompson Pellagra Commission, has gone to Mound, La., where he will be associated with Dr. D. L. Van Dine in the investigation of malaria mosquitoes. The work of the Bureau of Entomology on pellagra has been discontinued.

Mr. P. H. Timberlake, of the Salt Lake City laboratory, Bureau of Entomology, in Mr. Rockwood's absence, is being assisted by Mr. Bevan, a temporary appointee from Colorado, in the distribution of the Canidiella parasites of the alfalfa weevil. Colonies of this parasite have been established at Murray, Salt Lake, Ogden, Kaysville, and Taylorsville, and it is planned to place additional colonies at Holliday, Provo, Logan, Brigham, and Park City.

Mr. W. D. Pierce, Bureau of Entomology, made a short trip during June to Atlanta, Ga., for a conference with the State Entomologist, and Thomasville, Ga., to arrange for coöperation experiments between G. D. Smith of the Bureau of Entomology, and the Georgia State Board of Entomology, and to Clarksville, Tenn., for a conference with the men engaged in tobacco-insect investigations. He also visited various points in the boll weevil infested territory.

The Alabama Polytechnic Institute has conferred the degree of Doctor of Science upon Altus Lacy Quaintance in charge of Deciduous Fruit Insect Investigations in the U. S. Bureau of Entomology. Dr. Quaintance was at one time a student at this Institution, taking his Master's degree therefrom. This is the first Doctorate of Science conferred by the Institution and bears testimony to the high quality of the scientific work which has been done by Dr. Quaintance.

A new insectary building 19 by 25 feet is just being completed for the branch of truck-crop and stored-product insect investigations of the Bureau of Entomology. In addition to a spacious outside insectary for housing breeding material, the building will furnish laboratory headquarters for stored-product insect tests, and a number of effective appliances for testing methods of eliminating stored-product insects from prepared cereals and other materials infested by them are being installed.

Among the temporary appointees in the Bureau of Entomology who commence their work in June, are the following: J. H. Newton, of Arizona, who will be attached to the laboratory at Tempe, Ariz.; George R. Bailey will be attached to the laboratory at Gainesville, Fla.; J. H. Hart to the laboratory at Lafayette, Ind.; Eugene

Craighead to the laboratory at Hagerstown, Md.; W. B. Cartwright to the laboratory at Nashville, Tenn.; Miss Helen Atwood to the laboratory at Charlottesville, Va.; Lloyd Cortelyou to the laboratory at Wellington, Kan.; Miss Sally Hughes to the laboratory at Forest Grove, Ore.; and Manning Moody to the laboratory at Charleston, Mo.

A mosquito drainage law was passed by the last session of the Connecticut legislature, without appropriation, placing the work in charge of the director of the State Agricultural Experiment Station, who may approve work done by voluntary contributions. It is hoped that an appropriation will be made by the next legislature. New York State has also enacted laws permitting the counties of Kings, Queens, Richmond, and Bronx to inaugurate mosquito improvement work, the costs and benefits to be determined and certified to the assessors by the boards of health. Attempted mosquito legislation in Massachusetts has failed at the last two sessions of the general assembly. Thus progress along this line comes slowly though surely.

Mr. E. R. Sasscer, chief inspector of the Federal Horticultural Board, recently conducted some very interesting hydrocyanic-acid gas vacuum fumigation experiments with 30 bales of Egyptian cotton supplied by various New England cotton mills. The results of these tests indicate that the gas penetrates throughout the entire bale, and, in fact, adults of the common bean weevil (*Bruchus obtectus* Say), adults of the rice weevil (*Calandra oryza* L.), and larvæ of the clothes moths were killed at various points in the bales. This cotton has been returned to the mills, and is now being put through various milling tests in comparison with unfumigated cotton of a similar grade. All fumigated bales have been examined for residual gas, with the result that about five ten-millionths of a gram could be detected in each bale by the use of a very delicate test.

During the month of May a conference was held at Washington between representatives of the Bureaus of Animal Industry and of Entomology to discuss the project relating to the control of the house-fly and other insects in establishments operating under the meat inspection act, which was recently approved by the Secretary. Messrs. Bishopp and Laake of the Dallas laboratory attended this conference. Immediately thereafter these men, in company with Mr. Shaw, sanitary engineer of the Bureau of Animal Industry, visited the meat-packing establishments at Chicago, Kansas City, St. Louis, Forth Worth, and Dallas. Many interesting observations were made and a report has been submitted which will be placed in the hands of the inspectors of the Bureau of Animal Industry for their guidance in preventing the breeding of flies.

In connection with the Eastern Station of the Bureau of Entomology at East Falls Church, Va., there has been established a nursery which contains a number of species of conifers and oaks. The purpose of this nursery is to have immediately available small trees on which to conduct experiments dealing with oviposition, incubation periods, feeding of young larvæ, formation of galls, and the possibility of alternation of hosts of various forest tree insects. The Forest Service has supplied coniferous transplants in 100 lots of 21 different species, representing the following five genera: *Picea* (3 species); *Pinus* (12 species); *Abies* (3 species); *Larix* (2 species); *Pseudotsuga* (1 species). The oaks, which were secured by purchase, consist of 2 to 3 feet transplants of 10 individuals of each of the following species: *Quercus alba*, *Q. bicolor*, *Q. coccinea*, *Q. macrocarpa*, *Q. velutina*, *Q. rubra*, and *Q. palustris*.

Greenhouse insects, including insects affecting ornamental and flowering plants grown in the home, conservatory, cold-frames, and in hothouses or greenhouses, have been made the subject of a special project of the Bureau of Entomology to be

directed by Mr. E. R. Sasscer. Mr. A. D. Borden, who for the past year has been making life-history studies of the citrus mealy bug at Pasadena, Cal., has been transferred to Washington to assist in this project. The insect enemies of hothouse cultures of truck crops and small fruits, such as tomatoes, lettuce, cucumber, eggplant, strawberries, mushrooms, etc., will remain under the direction of the Office of Truck-Crop and Stored-Product Insect Investigations, as formerly. In connection with this new project Mr. Sasscer will coöperate with the Bureau of Plant Industry and with the officials in charge of the Botanic Garden and the propagating gardens and greenhouses of the War Department.

Mr. T. E. Snyder, Bureau of Entomology, returned June 23, from a ten days' trip through the southern Appalachian Mountains in Virginia, Tennessee, and North Carolina to study the present status of infestation by the southern pine beetle (*Dendroctonus frontalis*) and to collect material; also to study the blight on white-pine twigs and the galls on spruce caused by a species of *Chermes*. In the course of his trip, the White Top Purchase Area in Virginia and Tennessee was visited, where the Forest Service, cut and burned the bark in March, 1915, on approximately 1,600 infested pine trees. Mr. Snyder found only three trees containing broods of *D. frontalis*, and these trees were not in the immediate vicinity of treated areas, which indicates the success of the control work. In the study of the *Chermes* blight the stands of spruce on White Top Mountain in Virginia, elevation 6,711 feet, were examined, as well as the white pine in the valleys, but no evidence of the pine twig blight or new *Chermes* galls were found in the localities where both were so common last year.

Mr. F. C. Craighead, Bureau of Entomology, spent about two days at Chillicothe, Ohio, examining a large poplar plantation for insect damage and arranging for experiments in the control of the borer and other insects affecting the poplar. Also three days at Kanawha Station, W. Va., where he was successful in collecting a large series of all stages of the very rare cerambycid beetle (*Leptura emarginatus*) and making some interesting new observations on hickory, ash, and oak insects. Mr. Craighead has just returned from a trip to Boston to study the results of experiments in the control of *Agrilus bilineatus*, which is responsible for the death of oak trees defoliated by the gypsy moth. He reports that the experiments in disposing of the infestation in the principally infested trees has had a marked effect in reducing the number of dead trees. He also spent a day on Long Island inspecting the control work conducted on an estate against *Scolytus quadrispinosus* on hickory trees and *Agrilus bilineatus* on oak trees defoliated by cankerworms and tent caterpillars. He found that the control work had been done according to recommendations and with apparent success.

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Report of Special Meeting of the American Association of Economic Entomologists, Berkeley, California, August 9 and 10, 1915.

A special meeting of the American Association of Economic Entomologists was held at the University of California, August 9 and 10, 1915. Joint sessions were also held with the Pacific Slope Association of Economic Entomologists.

The attendance at each session averaged 45. Among the members and visitors present were the following:

E. A. Back, Honolulu, H. T.; E. D. Ball, Logan, Utah; F. C. Bishopp, Dallas, Texas; Lawrence Bruner, Lincoln, Neb.; A. F. Burgess, Melrose Highlands, Mass.; R. E. Campbell, Hayward, Calif.; Mrs. R. E. Campbell, Hayward, Calif.; H. G. Champion, Oxford, England; Leroy Childs, Hood River, Oregon; T. D. A. Cockerell, Boulder, Calif.; G. A. Coleman, Berkeley, Calif.; R. A. Cooley, Bozeman, Mont.; W. M. Davidson, Walnut Creek, Calif.; E. M. Ehrhorn, Honolulu, H. T.; E. O. Essig, Berkeley, Calif.; S. W. Foster, San Francisco, Calif.; Geo. P. Gray, Berkeley, Calif.; Ralph Hopping, San Francisco, Calif.; L. O. Howard, Washington, D. C.; S. A. Johnson, Ft. Collins, Colo.; A. L. Melander, Pullman, Wash.; J. M. Miller, Ashland, Oregon; R. L. Nougaret, Walnut Creek, Calif.; C. E. Pemberton, Honolulu, H. T.; D. O. Robinson, Imperial, Calif.; E. E. Scholl, Austin, Texas; Mrs. E. E. Scholl, Austin, Texas; H. S. Smith, Sacramento, Calif.; A. T. Speare, Honolulu, H. T.; Mrs. A. T. Speare, Honolulu, H. T.; A. E. Stene, Kingston, R. I.; A. F. Swain, Berkeley, Calif.; O. H. Swezey, Honolulu, H. T.; Mrs. O. H. Swezey, Honolulu, H. T.; T. D. Urbahns, Pasadena, Calif.; E. P. Van Dyke, Berkeley, Calif.; F. A. Varrelman, Berkeley, Calif.; H. L. Viereck, Sacramento, Calif.; Alfred Warren, Honolulu, H. T.; G. P. Weldon, Sacramento, Calif.; H. F. Wilson, Corvallis, Oregon; and G. N. Wolcott, Rio Piedras, Porto Rico.

In the absence of President Herrick the meeting was called to order by Prof. R. A. Cooley, first vice-president of the Association.

A committee consisting of H. F. Wilson and the secretary were appointed to arrange the program and Dr. L. O. Howard was called to the chair.

The following address was presented by Vice-President Cooley:

COMMENTS ON ORGANIZATION IN AGRICULTURAL COLLEGE EXTENSION WORK IN ECONOMIC ENTOMOLOGY

By R. A. Cooley, *Professor of Zoölogy and Entomology, Montana Agricultural College, Bozeman, Montana*

Certain factors, recently new, tend greatly to stimulate interest in extension work in economic entomology. The same factors have given a new impetus as well to the extension efforts in other departments of agricultural knowledge but to those branches of the agricultural college often spoken of as the science departments, and including entomology, which are concerned in the more specialized branches of agricultural knowledge and require particularly the service of specialists, the new movement comes bringing particular interest, new responsibilities and, above all, a great opportunity. In the opinion of the writer, official economic entomologists, in particular, are called upon to make a special effort in order that a right beginning may be made and that the fullest measure of good may result eventually from the present rapidly changing conditions. I refer in particular to the Smith-Lever Act which became a law on May 8, 1914, and to certain items in the appropriations to the United States Department of Agriculture which authorizes extension work, but which are being expended largely in coöperation with, and under the direction of, the agricultural colleges in the several states.

When the Smith-Lever Act becomes fully effective in the fiscal year 1922–23, if the states all accept the federal allotments, there will be available in the United States from federal and state treasuries the sum of $9,160,000 to which may be added unknown but very material sums from the United States Department of Agriculture and from upward of 3,100 counties, all of which sums are to be expended under the direction of the agricultural colleges in extending "useful and practical information on subjects relating to agriculture and home economics." There is a very general sentiment that the counties should each appropriate a sum equal to that received from the state and federal governments. If this standard is reached the sum, aside from that received through the Department of Agriculture, will be again doubled. We may, therefore, roughly estimate that this work will be supported in about ten years by something like $20,000,000 annually.

The agricultural college has thus laid out before it a new condition full of great possibilities to which it must adjust itself during the next few years. Economic entomologists are to share in the growth and development, but to what extent they will share will be influenced to some extent by the interest and zeal they show.

It has long been obviously true that a very imperfect use is being made of the great mass of practical entomological knowledge that has been accumulated. Remedial measures have been worked out for many of our more common insect pests, but, in many if not in most cases, these remedies are not put into general operation. As a rule the farmer recognizes and knows the proper treatment for only a very few of the chief insect offenders and the ones he does know are generally those which if left uncontrolled would very seriously affect his crop. In other words, he uses remedial measures only when driven to it and often overlooks the more obscure injuries which nevertheless greatly reduce his profits. Many a farmer has grown and harvested a crop and placed the returns in his bank without ever becoming aware that his profits were less than they should have been. A striking instance of a farmer having overlooked a serious injury to his crop may be related from the writer's experience. Reports of rather extensive damage to fall wheat due to the army cutworm (*Chorizagrotis agrestis* Grote) had been coming to the office from a certain part of Montana. Knowing that a certain man who lived in town had a large field of wheat in that neighborhood, he was asked if his crop was being injured and he replied that he had been at the farm and examined the grain the previous day and found no injury being done and no cutworms. In passing the field the day following the writer examined it for the insects and found that injury was being done throughout the field though no spots had been made bare. It was estimated that there were about two cutworms present for every square foot of surface and in some parts of the field the crop had been very seriously injured.

There can be no doubt that very much good has been accomplished through the agency of bulletins and circulars, correspondence, farm papers and institutes, but it is equally certain that farm practice may further be greatly benefited by putting into operation in a far greater degree the results of entomological investigations. Bulletins reach the farmer irregularly and if read are not often preserved. Many farmers dislike to write letters and find it difficult to thoroughly state their problems. Institutes are few in number, often come at a busy time of the year and frequently are held at a considerable distance from the home. The results of a survey made by the Bureau of Plant Industry and published in Circular No. 117 showed the farm papers to be the most popular among the various helpful agencies, but specialists are often disheartened as they observe how inadequately these papers meet the requirements. Entomologists have observed in the papers not only grave errors, but discussions that do not apply at all to the conditions that the readers of the particular paper have to contend with. If the entomologist criticizes he is asked to prepare more articles

which only further indicates that the public is in need of reliable information. Of all of these agencies it may be said that they are largely lacking in the element of vital contact with the farmer's real needs.

Our knowledge of insects and of means of control have gone far in advance of the farmer, and entomologists, in particular, are in need of such a means as has been provided for disseminating knowledge of insect control and demonstrating its value. We may or we may not approve entirely of the details of the method that is being so rapidly established but it has come to stay, apparently, and we may as well face the fact and prepare to meet the conditions.

The Smith-Lever Act specifies that its benefits shall be applied through the college or colleges now receiving the benefits of the first and second Morrill acts, that is, the agricultural colleges, which in some states are separate institutions and in some are maintained as colleges in the state universities. The problems incident to the new work, therefore, come to college rather than to experiment station officers. The act is broad in its provisions with respect to how the funds shall be made effective. Nobody knows what the completed organization shall be or how the many questions that are arising are to be met. Already, however, the states have in large measure committed themselves to the employment of resident advisers in the counties. These have received various names, including farm demonstrators, county agriculturists and county agents. For the purposes of the remainder of this paper they are called "county agents" or "agents."

The college departments' relationship to the county agent needs to be carefully defined. In the nature of the case the men to fill these county positions must be general in their training and experience. They cannot be specialists, though it is entirely possible that as the system develops special agents or specialist agents may be employed to meet local requirements. These, however, will be few in number, at least for many years.

Yet these generally trained men will be the ones to whom in large measure the requests for information regarding the identity, life-histories and control of insect pests will come. They are the ones who will be in contact with the people. In this respect, the system is weak but under the circumstances it is the best that can be provided and with proper coöperation good results may be secured. The county agent will need the help and backing of his college and a clear understanding of what is expected of him, for he has little precedent for his guidance and since he is the mouth-piece of many college departments and is expected to teach truly their doctrines, he has, in a sense, many masters.

His relationships with the home institution will necessarily be very complex and we can do little more at the present time than to state some general observations. He should consider himself to be not a dissociated, independent factor, but rather a medium of communication between the specialist and the farmer. He should realize that he is to dispense facts and not opinions and should early learn to practice the delicate art of saying, "I don't know" when confronted by questions that go beyond his knowledge or experience. He needs to be reinforced by the assurance that questions referred to the college will be answered promptly.

For his part the specialist should, through deliberate plans, make a renewed effort to be helpful to the farmer through the agent. This point is discussed more at length below. It is apparent that close relationships and a complete understanding should grow up, paving the way for the quick settlement of questions that must arise.

Numerous questions are arising. Following are some examples. Should agents train their farmers to make requests for information of the home institution through them? To what extent shall agents first get the approval of the home departments before starting special campaigns? Shall copies of the agents' periodic reports be referred to the departments? It is believed that all such questions as these may be satisfactorily worked out by an observance of the general principles outlined above.

In the past in many states a single entomologist has alone, or with little assistance, carried all four branches of the state's entomological service, namely, investigation, teaching, extension and law enforcement. That day is passing. The agricultural colleges generally retain one man as head of all entomological work in the institution and he, yielding to the dictates of efficiency, is finding it necessary to employ special investigators and special teachers.

It seems desirable, first, to recognize as tenable the primary divisions of the work suggested above, not that we are called upon to at once, or perhaps ever, draw hard and fast lines of separation, but because as development occurs and new men are added, specially qualified assistants may be secured and all of the details of organization may be planned to harmonize.

It is believed that at the outset we should recognize the extension work as a distinct and important branch of the state's work in entomology rather than to attempt to accommodate the new duties among our miscellaneous activities. Each state will need one man or more whose duty it is to serve the needs of extension work and as entomologists generally now recognize teaching, research and law enforcing as natural branches, they will probably some day recognize extension work. It

is not unlikely that at some future time when there are a considerable number of entomologists who are especially interested in extending knowledge of economic entomology, there will be established a division or branch of this Association to facilitate interchange of ideas. For our present purposes we may call him the "extension entomologist." Some states have had field representatives who have been of much service in keeping the home institution in touch with field conditions. These men have been charged particularly with getting information from the field, rather than with giving it to the farmers. It will be but natural to combine in the duties of the extension entomologists the work which some states have had the field men do; that is, as they are about the state do special errands, such as collecting specimens, materials and notes for the use of the research men and teachers. He can be of great service in numerous ways. His special interest will be to gather and systematize information from all sources, but particularly from his co-workers in his own state and not only get it to the farmer, but get it into practical use by the farmer. While his particular interest is to effectively extend knowledge he need not and should not lose the same scientific spirit that now actuates entomologists. We wish the results of our investigations to be taken to the farmer by the entomologist and in the same spirit as in the past. It could not be as effective to have entomology combined in one man with some other special line, perhaps plant pathology, though for a few years we may be called upon to accommodate ourselves to such adjustments. We should, as soon as possible, have our own representatives in the field.

Farming interests have suffered heavily in the past through the experiment station's being uninformed or poorly informed concerning insect injuries that are taking place. The extension entomologist may, through his county agents and through his own observations, do much to prevent widespread damages. In Montana this spring we experienced a widespread and very serious outbreak of army cutworms. In one county, alone, it was estimated that 12,000 acres of fall grain were eaten off, requiring replanting. We have no way of knowing just how many acres of grain were destroyed in the whole state, but it is probable that 100,000 is not very far from correct. Beside this, many thousands of acres were saved through the timely use of remedies which the state entomologist recommended. Much more could have been saved if the office had been informed in time. If the agents had been trained to observe the first indications of the presence of this insect or if the department had had a representative in the field, we should have received earlier advice.

It is too early to completely outline the duties of the extension entomologist, but some things he should do are already apparent. In

the first place, the agents will naturally apply directly to him for information and he will be in charge of the department's relationships with agents. He will naturally travel much, going from one agent to another and helping in the solution of local problems, looking into outbreaks and aiding in their control. He will naturally aid in survey work in states where this is under way and will contribute to the building up of the department's collections.

The extension entomologist should be much in demand for lecturing at institutes, in short courses at and away from the home institution and in high schools. In this connection he may equip himself with charts, lantern slides, demonstration materials and life-history exhibits. He may prepare many circulars of information and articles for newspapers.

In placing emphasis at this time upon the importance and utility of extension service in entomology, the writer wishes particularly to be not understood as losing a sense of perspective or of losing sight of the importance of the other branches. This new movement should be received and adopted by official economic entomologists as a unit to be placed among the other units in the state's entomological system. It will have, therefore, its organic relationship to the other branches of the service. We cannot at this time enter upon a full discussion of these matters, but some comments seem to be timely.

We have mentioned a primary classification of official entomological service. The fundamental or central branch is undoubtedly research and an effective state organization will necessarily give a large place to investigations which will go deeper and deeper into the unknown and more and more illuminate the whole system. The main interests of entomological departments will undoubtedly continue to be research and teaching. The teacher of entomology, the extension worker and the inspection official must always look to the investigator to supply that element which gives stability to their work. At the same time, in whatever branch of the work one finds himself, it is believed that it is necessary that he keep alive in himself the true spirit of the scientist, a love for the truth, a worthy desire to uncover the unknown and add to knowledge. The extension entomologist can continue safe and reliable only as he keeps in touch with the on-movement of his science. Accordingly, he should be given an opportunity to a limited extent to work out some of the problems that arise in connection with his own work; that is, do some investigational work. He should be always essentially an entomologist even though engaged in extension work.

Another point that should be made is that, while in the past station entomologists have been expected quite generally to attend to all mat-

ters of insect control, such as correspondence, lecturing and newspaper writing, they should now be largely relieved of these extras. There has grown up a strong tendency toward confusing extension work and experiment station work. The farming public has needed help and the station has been the natural place to go for it. Yet the federal acts by which the experiment stations are endowed do not authorize extension work. When the results of investigations are published, the experiment station's responsibility ceases and the investigator, paid from federal funds, who turns aside from his studies to lecture to farmers, to write for the farm papers or to aid farmers by correspondence, if he does so to the extent of reducing the effectiveness of his researches, is not only infringing on the law, but reducing the efficiency of the organization. The situation has been met in the past by having the specialist's salary paid in part from state funds over which federal authorities have no jurisdiction. This has resulted in interruptions and delays with which we are so familiar. The most serious effect has been perhaps a reduction in efficiency in research workers. There has grown up a tendency to accept and adopt standards which are lower than can be attained by allowing investigators to pursue their studies without serious distractions.

In conclusion, emphasis should be placed on the fact that the passage of the Smith-Lever Act and the events which have grown out of it are of the greatest importance to economic entomologists. A new era of far-reaching developments seems to be indicated. In the past, entomological work has not received the public recognition that its importance merits, largely because of widespread popular ignorance of the subject, and if entomologists will be quick to see the significance of the new extension movement and to act, the scientific interests which we represent may be greatly benefited.

The most immediate result should be an increased demand for well-trained young economic entomologists. Many new positions should be opened during the next few years as the extension funds become available and this will affect teachers and research men as well as extension workers. This is clear when we stop to think that, in preparing men for the extension service, the teaching department will be called upon not only to teach entomology to the men who will become the county agents, but to train those who will serve as extension entomologists of which there should be eventually many.

Having one or more trained observers out in the state much of the time will put the college in touch with problems that require attention and will suggest lines of research. These problems will naturally be the ones that the farmers are interested in and a greater measure of sympathy and coöperation between the farmer and entomologist should

result. In Montana, we have already felt a marked increase in the demands for help from the farmers. These are coming partly through the agents, and the agents are always glad to coöperate in these matters, so far as they are able, for they feel that in this way they can show positive, tangible results, leading to outspoken approval from the farmers.

Another result should be that we will fare better at the hands of the legislatures in all of our funds, but particularly in the appropriations for research. This should be brought about through the farmers and general public becoming better acquainted with the methods of work, aims and results of entomological research.

Dr. L. O. Howard: The address is now open for discussion.

Mr. A. F. Burgess: The point made in the address in regard to securing well-trained entomologists, particularly in connection with demonstration work on the farm, merits careful consideration. It would seem well to keep this matter constantly in mind when positions are being filled.

Dr. L. O. Howard: One of the strong points in this address is that it looks forward to the future. Aside from being concerned with present conditions, it takes up in a comprehensive way future conditions and prospects.

At the conclusion of the discussion the session adjourned at 11.30 a. m. in order that the Pacific Slope Association of Economic Entomologists might hold a brief session.

Afternoon Session, August 9, 1915

The session was called to order by Vice-President Cooley at 2 p. m. This was a joint meeting with the Pacific Slope Association.

Mr. H. F. Wilson reported that at the Session of the Pacific Slope association a committee consisting of Mr. E. D. Ball and Mr. E. O. Essig had been appointed to consider what steps could be taken in order that the Pacific Slope Association might affiliate with the American Association of Economic Entomologists. He requested that a committee of two members from the latter Association be appointed to consider the matter with the committee already appointed.

It was voted that a committee be appointed, and the chair selected Mr. C. P. Gillette and Mr. A. F. Burgess to represent this Association.

The following committee on resolutions was appointed by the chair, Messrs. E. A. Back, F. C. Bishopp and A. L. Melander.

Vice-President Cooley: The first paper on the program will be presented by Mr. Geo. P. Weldon:

THE WOOLLY APHIS AS A PEAR PEST

By G. P. Weldon, *Sacramento, Cal.*

(Withdrawn for publication elsewhere.)

Vice-President Cooley: The next paper will be read by Mr. O. H. Swezey.

SOME RESULTS OF THE INTRODUCTION OF BENEFICIAL INSECTS IN THE HAWAIIAN ISLANDS

By Otto H. Swezey,

Entomologist, Experiment Station of the Hawaiian Sugar Planter's Association, Honolulu, Hawaii

Only a very few of the native insects of the Hawaiian Islands have become injurious to cultivated crops or plants. The insect pests occurring there are in most cases foreign insects that have arrived through the channels of commerce. The promiscuous importation of fruits, seeds, trees, plants, etc., from all parts of the world has been the chief way by which the numerous insect pests have gained access to these islands. One has but to observe the profusion and variety of trees, shrubs, and plants in the public parks and private grounds of Honolulu to realize to what extent this has been carried on, for in all of this there is only an occasional native tree or plant to be seen.

The most of this introduction of trees and plants was done before the present rigid system of plant inspection and quarantine against insect pests was instituted, and the insects have come along freely with their host plants. There are about seventy-five species of scale insects known in the islands, none of which are native, but all have been brought in in this way. The sugar cane leaf-hopper, too, so well known from its having caused such heavy loss to the sugar industry, is a striking example of a pest arriving with its host plant, coming in as it undoubtedly did in the egg stage in importations of cane cuttings for planting.

Many insects have arrived in other ways through the channels of commerce, as in packing, in soil about the roots of plants, along with domestic animals, chance travellers on board vessels, etc. Some, not pests in their home country, have become pests here when established in the absence of their natural enemies. Observations on this line have led to the practice which is now so prevalent of searching for the

native home of a pest and making a study of its natural enemies for the purpose of introducing them to the countries where the insect has become established as a pest.

Considering its size, Hawaii has probably accomplished more in the way of combating insect pests by the introduction of their natural enemies than has any other country. The first introduction of beneficial insects in Hawaii was when, following his remarkable success in the introduction of an Australian lady-beetle (*Novius cardinalis*) into California to destroy the cottony cushion scale, Mr. Albert Koebele also introduced it here, where it soon reduced the same pest to such scarcity that it is no more a menace to the trees and plants previously affected. A few are to be seen now and then on various plants and trees, but the lady-beetle is in such control that no serious infestations now occur.

This introduction was as early as 1890, and shortly after, in 1893, Mr. Koebele was engaged by Hawaii to continue this work of finding and introducing beneficial insects. Many of the first successful introductions were lady-beetles. About a dozen different species were successfully introduced by 1896, mostly from Australia and the Orient. Among these were *Cryptolœmus montrouzieri*, *Rhizobius ventralis* and *Rhizobius toowoombæ* which feed on various species of mealybugs; *Cœlophora inequalis*, *Platyomus lividigaster*, *Scymnus lœwii* and *Scymnus notescens* feeding on plant-lice; *Orcus chalybœus* and *Chilocorus circumdatus* feeding on scale insects. Many other lady-beetles have been tried, but not all were successful. Some failed to become established, and others, although established, failed to increase sufficiently as to be of noticeable use. However, the combined work of all mentioned above has reduced greatly such pests as mealybugs, scale insects and plant-lice.

Thirty or more species of hymenopterous parasites have been introduced, also, to prey on this class of insect pests. The lady-beetles are often seen busily feeding upon their respective hosts and the general public recognizes them as beneficial; but the parasites, often very minute, are seldom seen, and hence their usefulness is not generally known by people unfamiliar with their habits. Their presence may be determined by close examination and finding the tiny round holes which they have gnawed in the scale insects, in emerging from them, after completing their transformation in the place where they have been feeding on the living bug, or its eggs, beneath the scale. These scales with the tiny holes may often be found in great abundance on scale-infested plants, mute evidence of the usefulness of the parasites.

Among the most valuable of the introduced Coccid parasites are: *Encyrtus fuscus*, *Blepyrus marsdeni*, *Microterys flavus*, *Apentelicus*

kotinskyi, Adelencyrtus odonaspidis. Scutellista cyanea, Tomocera californica, Tomocera ceroplastis, Aneristus ceroplastæ, Coccophagus orientalis, Coccophagus lecanii, Aphelinus diaspidis and *Aspidiotiphagus citrinus.*

The usual sequence of beginning, increase and decline of an outbreak of mealybugs or plant-lice is often to be seen. The pest may get a start at a time or in some place where there are none of its enemies, and may increase considerably before being found by any lady-beetles or parasites. These latter, having arrived in small numbers, begin to reproduce, and after a few generations increase sufficiently to become effective in checking the increase of the pest; then, after still further increase in numbers, finally exterminate the pest entirely. After such an outbreak of mealybugs, the adults and larvæ of the lady-beetle, *Cryptolæmus montrouzieri,* may be seen in thousands, and their pupæ also in large numbers where the larvæ have congregated in some sheltered place for pupation.

An occasional occurrence of this kind serves to illustrate the usefulness of the parasites and lady-beetles, and also shows what conditions might prevail continuously if these pests were not kept pretty well in check for most of the time. More of these lady-beetles and parasites would be useful, and the entomologists of Hawaii avail themselves of every opportunity of securing them.

Leaf-roller Parasites

In 1895, among other parasites that Mr. Koebele introduced from Japan were *Chalcis obscurata* and *Macrodyctium omiodivorum,* which attack the pupæ and caterpillars of the leaf-rollers on sugar cane and coconut palms. These two parasites do a great deal of good in killing off these leaf-rollers. *Chalcis obscurata* also parasitizes the pupæ of several other leaf-rollers of fruit trees and garden plants, among them *Archips postvittanus* and *Amorbia emigratella,* once very abundant but now not very injurious.

Macrodyctium omiodivorum is a small Braconid and chiefly attacks the larvæ of the sugar cane leaf-roller, *Omiodes accepta.* This is a native moth whose larvæ normally feed on grass and are always to be found in grassy regions, especially at elevations of 1,000 to 3,000 feet. Sugar cane fields in the vicinity of such regions are often subject to severe attack and considerable injury by these caterpillars. Since the introduction of the Braconid, the leaf-rollers have been held in check in the cane fields, or if outbreaks occur at any place they are soon found by the parasites, which, having a very short life-cycle, are soon able to increase sufficiently to check the pest.

Lantana Insects

Another phase in the introduction of beneficial insects was the introduction of the lantana insects by Mr. Koebele in 1902. He made a thorough study of the insects preying exclusively on lantana in Mexico, to ascertain which could be safely introduced to serve as a check on this plant in Hawaii. Among the many species of insects studied, eight were successfully introduced and finally spread all over the islands. Of these insects, the maggots of the little black seed-fly (*Agromyza* sp.) destroy the seeds in the growing berries; the larvæ of two moths (*Platyptilia pusillidactyla* and *Crocidosema lantana*) feed in the flower clusters, thus helping to prevent the formation of fruit; the caterpillars of two butterflies (*Thecla echion* and *Thecla agra*) feed on the flowers; the larvæ of a tiny moth (*Cremastobombycia lantanella*) mine the leaves, thus causing them to become ineffective in the service of the growing plant; a small bug (*Teleonemia lantanæ*) feeds abundantly on the underside of the leaves, causing them to die and fall off; a gall-fly (*Eutreta sparsa*) produces large swellings or galls on freshly-growing shoots, thus checking the normal growth.

The growth of lantana has been greatly checked by all these insects, and in some places their effect, in connection with climatic conditions, has killed it off entirely. The greatest benefit derived has been from the destruction of the flowers and seeds, so that land once cleared of lantana does not again become invaded by it; whereas formerly on the cattle ranges a great deal of expense was involved in continuously rooting out lantana, for it was always being reseeded by birds dropping the seeds broadcast. Now, very few seeds are formed, as many of the flowers are destroyed by the larvæ of the two butterflies and the two moths above mentioned, and what seeds do start to grow are mostly eaten by the larvæ of the Agromyzid fly.

There has been considerable fear on the part of some that the introduced lantana insects would become pests on other plants, especially when the lantana became scarce or killed out, but such has not been the case. None of these insects have ever become injurious to any cultivated fruit or plant, and it is indeed doubtful if any such plant has been in the least attacked by them. It is of interest to note in this connection that at the time the Mediterranean fruit-fly first became known in Honolulu, an opinion expressed by many of those ignorant of the ways of insects, was that the "lantana fly" had changed its habits and turned into the fruit-fly, thus becoming a bad pest. Some were so thoroughly imbued with this idea that it was impossible to convince them of their error.

Sugar Cane Leaf-hopper Parasites

The most noted case of introduction of beneficial insects in Hawaii occurred in 1904–05, when Messrs. Koebele and Perkins introduced from Australia and Fiji the egg-parasites for the sugar cane leaf-hopper, *Perkinsiella saccharicida*. These were three Mymarids (*Paranagrus optabilis, P. perforator* and *Anagrus frequens*) and a Chalcid (*Ootetrastichus beatus*). Attempts were made to introduce others of the many parasites that were found preying on leaf-hoppers in Australia and Fiji, but these egg-parasites and a Dryinid were the only ones that were successful.

They soon became established and were spread throughout all the sugar plantations, and within two years had made such a reduction in the number of leaf-hoppers in the cane, that there was already an appreciable amount of benefit derived, and after two more years there was comparatively little complaint of injury or loss by the leaf-hoppers. Sugar cane was again grown without the severe setback which young cane was always subject to when the leaf-hoppers were at their worst, and which often resulted in ruining whole fields; in one instance almost all the fields of a large plantation of 9,000 acres.

The year preceding the establishment of the parasites, the estimated loss from the leaf-hopper amounted to $3,000,000 for all the plantations of the islands, and the sugar industry was threatened with ruin. After the establishment of the parasites, this annual loss was diminished yearly, until in a very few years the loss by leaf-hoppers was considered negligible. Yet even now, after ten years, there are occasional severe local outbreaks of the leaf-hopper, when whole fields or spots in certain fields suffer considerably from their attack; but this is usually only temporary, and there are no general outbreaks.

Of the different parasites, one of the egg-parasites (*Paranagrus optabilis*) has been the most useful one. The others are not always to be found everywhere, but this one is always found anywhere and everywhere that there are any leaf-hopper eggs for it to breed in. It is usual to find 50 per cent or more of the eggs parasitized by it. When the shortness of its life-cycle is considered, it being three weeks as compared with six weeks or more for the leaf-hopper, it is seen what advantage it has in checking the latter. It has been the main factor in this natural control of the leaf-hopper, though the other introduced parasites and some local parasites and predators have been very useful and played an important part.

Cane Borer Tachinid

Another remarkably successful parasite introduction was a tachinid (*Ceromasia sphenophori*) parasitic on the sugar cane weevil borer (*Rhabdocnemis obscura*). This was brought from New Guinea by Mr. F. Muir in 1910. An account of his search for parasites for the cane borer, the finding of this tachinid and its introduction to Hawaii are given in the Journal of Economic Entomology, Vol. VII, page 455, 1914. Within two years the tachinids had been distributed to nearly all plantations and well established in many of them. Nearly five years have now elapsed and the beneficial results are very apparent. Already, in 1913, the tachinids had become sufficiently abundant to cause a considerable reduction in the number of borers in the cane, and a consequent diminution of damaged cane resulting in an increased yield of sound cane per acre. This was especially noticeable in those plantations where the pest had been the worst, and where on this account efforts to establish the tachinids had been concentrated at the outset. On one of these plantations where the manager was keeping definite records, and the usual infestation by borers was 30 per cent of the canes, it had dropped to an infestation of only 12.77 per cent. This has resulted in a greater yield of good cane per acre, and at the same time the quality of the juice in the cane has been so much improved that more sugar is produced per ton of cane. To use figures from the plantation reports: it now requires 1.67 tons less of cane to produce one ton of sugar than it did formerly.

Another plantation, that has been similarly benefited, reports that its yields have been increased by a little over two tons of sugar per acre. If the price of sugar be taken at an average of $75 per ton, this would mean a saving of $150 per acre, and the plantation harvesting 1,000 acres annually would have a saving of $150,000.

Not all plantations have been benefited to the extent of these used as illustrations, for not many were so severely infested by borers as these were, but many have been very considerably benefited. The total saving to the sugar industry of the Islands would amount to many thousands of dollars annually. It is significant that the crop of sugar in 1914 was 21,780 tons greater than any previous crop in the history of the sugar industry in the Hawaiian Islands.

Present conditions indicate that the tachinids have reached their maximum efficiency, for they are now less abundant in the fields than they were shortly after the time when they became generally spread. This is by reason of the reduction in the number of borers. Where the borers were formerly most numerous, it gave the tachinids oppor-

tunity to increase until for a time they were very abundant, but later became scarce, corresponding to the scarcity of the borers brought about by them. In many places it is now difficult to find injury by borers where formerly much cane was injured, and similarly the tachinids are difficult to find in these places.

Fruit-fly Parasites

Several species of fruit-fly parasites were brought from Africa and Australia by Dr. F. Silvestri in 1913. Some of these were reared successfully in large numbers and widely distributed. The following year two species (*Opius humilis* from Africa and *Diachasma tryoni* from Australia) were found to be established and quite widely spread. In 1914, Mr. D. T. Fullaway brought several more species of fruit-fly parasites from Africa, which have likewise been reared in large numbers for distribution. It has not yet been long enough to expect extensive results from these introductions, but there is hope that when several of them are well established and generally spread much good will result.

In this short paper only the more important of the introduced beneficial insects have been mentioned. There have been many others of less importance, either by reason of their attacking less important insect pests, or that they failed to increase in sufficient numbers to be of significant value. There have been many tried which for climatic or other reasons entirely failed to become established. Many attempts have been made to find and introduce useful natural enemies for the horn-fly on cattle, but none of them so far introduced have brought about any noticeable general reduction of the pest.

The entomologists of Hawaii, encouraged by those which have been successful, are continuing in this method of combating insect pests, and from one or the other of the institutions there, projects for the introduction of more beneficial insects are continually being carried on.

Mr. E. D. Ball: What is the native home of the sugar cane leaf-hopper?

Mr. O. H. Swezey: It was supposed to be in Australia. Parasites were secured from there, also from Borneo, New Guinea and Fiji. We are not certain of the native home of the leaf-hopper. It is not a pest in the countries mentioned.

Dr. L. O. Howard: Hawaii has done more than all other countries put together in the matter of introducing parasites successfully. The introduction of insects to feed upon weeds or other plants is a dangerous experiment and it is very fortunate that it turned out so well in this case.

Vice-President Cooley: The next paper will be presented by Mr. Leroy Childs.

SPRAYING NOTES ON THE CONTROL OF THE FRUIT TREE LEAF-ROLLER IN THE HOOD RIVER VALLEY

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In the face of the already valuable information that is available on the life-history and the control of the leaf-roller, this paper and the work that it represents might appear to some as superfluous. In citing the literature, however, I find little or no published experimental work dealing with the control of this serious and numerically increasing apple pest on the Pacific Coast. A still more important point which made experimentation, at least with the oils, imperative was to determine if possible what influence spring applications of oils have on the adhesive properties of fall applications of Bordeaux mixture. In the Northwest we have a very serious apple disease known as apple tree anthracnose, for control of which Bordeaux is applied before the early rains in the fall. It has been suggested, and seems, indeed, quite possible, that there may exist some such condition, information relative to which is desired before the general use of oil can be recommended. The anthracnose spray has not been applied with the result that a report on this point is impossible at this time. The leaf-roller, however, has passed through its period of activity for this season and the data gathered relative to its control is complete.

In the Hood River Valley the presence of the apple leaf-roller is not general. The limits of the present infestation are well defined, comprising at the present time some five hundred or six hundred acres. A yearly expansion of these limits occurs and the losses are increasing, with the result that the orchardists are planning a vigorous campaign against the pest next year.

At no time in Hood River has the infestation occurred to such an extent as to cause noticeable defoliation; occasionally the tender foliage of growing terminals is severely injured but in no place has there occurred the complete defoliation that has been reported in different sections of the East. The injury to the fruit, however, in several orchards where extensive countings were made produced surprising information. The losses incurred by the feeding worms often approached 40 per cent of the entire crop. It was found that the injury was even more severe on trees in light bearing, where the percentage of injury amounted to

more than 50 per cent. This loss, together with the other losses that must be considered in the form of scab, codling moth, bruises, etc., make it imperative that some means be employed in reducing this waste.

In order to determine the most advantageous method that could be employed under Hood River conditions, a series of experiments embracing lead arsenate in various strengths, crude oil emulsion, kerosene emulsion, distillate emulsion and a miscible oil were used during the past spring.

Owing to the fact that it is necessary to make four or five spring and early summer applications of a fungicide for apple scab control in Hood River, lead arsenate, if efficient, seemed to offer the least expensive plan (at least from the standpoint of labor) in bringing about leaf-roller control, for this material is usable in combination. Six different plans of procedure were outlined. Lime-sulfur was the fungicide employed throughout the season. Spraying in the spring began in what is termed at Hood River the delayed dormant spray, or an application applied at a time when the more advanced foliage has reached the size of squirrels ears. At this season it was very difficult to find any hatched leaf-roller eggs.

The orchard in which the experiments were conducted is planted to Spitzenburg apples which are now about twelve years old. Two rows across the orchard were used in each experiment. Between each was left one as a check. In referring to the table it will be seen that countings from each of these rows serve as a check on two experiments. The degree of infestation, based on the presence of egg masses, indicated that it was at least typical of the conditions as existing in the valley. A power sprayer fitted out with a "New Way" engine and two leads of hose was employed throughout the season in applying the materials. Frembo nozzels with a medium sized hole in the disc were used.

Two essentials were considered in the scheme of the arsenate experiments: first, to determine, if possible, the least amount of poison that must be used in bringing about control, and second, to determine if possible the insect's most susceptible period to poison.

With these thoughts in mind, six experiments were outlined. Referring to the table it will be seen that in all six experiments, lead arsenate was used in the delayed dormant application, that the poison might be present as the worms hatched. In the delayed dormant spray lime-sulfur was used at the rate of 1 to 18 throughout. To this fungicide was added in experiment 1 and 3, arsenate of lead (paste in all cases) at the rate of 2 pounds to each 50 gallons; in experiment 2 and 4, 4 pounds to each 50 gallons and in experiments 5 and 6, 6 pounds

to each 50 gallons of water. A large number of egg masses were examined at this time; none of the eggs were found to be hatching, the embryonic development was far advanced. The date of this application was April 3.

A second or "pink application" (*i.e.*, at the time the flower clusters were beginning to show pink) was made on April 14. The fungicide employed was as in the first, lime-sulfur, used, however, in a more dilute ratio, 1 to 27. The arsenate of lead was omitted in experiments 3, 4 and 6. The poison applied at this time in experiments 1, 2 and 5 was in the same strengths as used in the delayed dormant spray 2, 4 and 6 pounds respectively. To determine the condition of the eggs, a large series of egg masses were examined and it was found that hatching was actively taking place, 58 per cent of the worms having emerged. On the 20th of April, or four days later, no unhatched eggs could be found. At this time a large portion of the foliage was still well covered with the poison. From these observations it is clear that material placed upon the trees during the time that the blossom buds are showing pink is most advantageous with reference to the emergence of the worms.

Unfortunately, a series was not run in which a "pink" spray only was used; a series of this sort would undoubtedly show more clearly the relative values of this application than can be shown with the data at hand.

At the time of the calyx application, May 1, a large majority of the worms were found beneath the folded, web-covered leaves and so located that their food was protected for the most part from materials that could be applied in the form of spray. In view of this fact, a codling moth spray of 3 pounds to 50 gallons only was added to the lime-sulfur 1 to 36 in all of the experiments For fear of codling moth infestation, the check rows were sprayed at this time, also. The data gathered from the counts made on the check rows, consequently, hardly give accurate information relative to the losses that might occur should all spraying be omitted. In looking over the experiments after the calyx spray, many ailing worms were found and others that were dead, all of which seems to indicate that, where available, this strength is sufficient to destroy the worms.

The fourth spray of the season or the second codling moth spray was applied May 29. This consisted of arsenate of lead, 3 pounds to 50 gallons of water, plus the lime-sulfur 1 to 30. Fruit only received attention at this time, all of which were thoroughly covered. In early June a great deal of fruit injury was noted taking place and in many cases the small apples were found largely consumed. The worms in folding and rolling the leaves often incorporate many of these little

apples, and those so surrounded with foliage are invariably ruined. This feeding on the fruit, though often not very extensive, devitalizes the apples to such an extent that they stop growing and drop. On account of this existing condition, it was thought best to check up the experiments as soon as the feeding period of the insects was over rather than waiting until harvest time. In so doing, thinning of the fruit was permitted on the plats where it was found to be necessary.

A thousand fruits or thereabouts were counted in the various experimental plats and checks. These were made from representative trees chosen at random in the plats. In comparing the results that were obtained, it is clearly indicated that none can be pronounced as efficient in controlling the leaf-roller, though some benefit may be derived from as weak application as 2 pounds to 50 gallons. In experiment 1, where 2 pounds to 50 gallons were employed in the delayed dormant and in the pink sprays, a benefit of 9 per cent was obtained when compared with the check. Contrasting this experiment with 3 in which the lead was omitted in the pink spray, the results clearly show the time at which the poison is an active agent in destroying the worms. In this experiment there is only a 3 per cent difference between sprayed and unsprayed fruit. The inefficiency of the delayed dormant spray is more clearly shown in experiment 4; here 4 pounds of the lead arsenate were used to 50 gallons. The fruit count shows a 27 per cent loss on account of roller injury or five tenths of one per cent less than the check. This is 2.5 per cent more injury than was obtained where the weaker arsenical was used. This discrepancy falls within that allowed for experimental error.

The extra two pounds of lead to 50 gallons of water in experiment 2 decreased the fruit loss by 3.8 per cent, giving a total fruit injury in this experiment of 15 per cent or a reduction of a little less than half of the losses that occurred on the unsprayed trees.

In experiment 5, where lead arsenate at the rate of 6 pounds to 50 gallons was used in the two early sprays, more encouraging results were obtained. Even with this heavy dosage, however, 11 per cent of the fruit was found to be damaged. On trees heavily loaded with fruit, a loss of this percentage would not be very severe as a large part of this could be overcome by judicious thinning. In years of a light crop, however, a condition which exists this year, and where all of the fruit should be retained, more efficient remedial measures than arsenical poisoning should be employed. Unfortunately, experiment 6 was conducted on Johnathans, a variety which is not subject to severe attack, in Hood River at least, by the roller, so that comparative data as noted in the other experiments were not obtained.

In times past, oils have been used by local growers in an attempt to control the leaf-roller, with rather indifferent success. Owing to existing conditions it was thought best to test out a series of materials. Four oils were used in eight experiments as follows: kerosene emulsion, 18 per cent, distillate emulsion, 18 per cent, crude oil (Balfour Guthrie Co.) in the ratio of 1 to 12 and 1 to 15 and miscible oil No. 1, manufactured by the above company, in four strengths, 5, 6, 7, and 8 gallons to the 100 gallons of water.

Some of the pioneer workers in leaf-roller control have at various times recommended kerosene as an effective means of destroying the eggs of the leaf-roller and the 18 per cent emulsion of this material was placed on the trees with confidence that many eggs would be destroyed. The trees were thoroughly covered, in fact drenched, 5 to 6 gallons of the material being applied to each tree. When a count of the eggs on the experiment and check was made, it was found that a larger portion of the eggs on the sprayed trees, or 96.4 per cent, hatched as compared with 95 per cent hatched on the control trees. A duplication of this experience was encountered with the distillate; here again no ovicidal properties were found to exist when applying an 18 per cent emulsion. The trees were examined the day after the material had been applied and it was found that nearly all of the evidences of the oil had disappeared. When used within the bounds of economy, both of these materials are lacking in sufficient penetration qualities to be considered a means of destroying leaf-roller eggs.

The results that were obtained with the crude oil proved disappointing, also, from a point of control. The material was used in two strengths, at the rate of 1 gallon of oil to 12 gallons of water and 1 gallon of the oil to 15 gallons of water. These emulsions were applied May 27. The variety of trees in the experimental plats were twelve-year-old Spitzenburgs on which many egg masses could be found. On the day that the spray was applied the more advanced buds were noted already burst and some of the first leaves were out. Upon examining the plats a few days later many of the early leaves were found to be injured. They, for the most part, were not burned but seemed to be stunted and had an oily appearance for several weeks, a condition which was not observed in the other experiments. This greasy condition existed on much of the foliage for several weeks, retarding and causing a malformation of the leaf growth on many of the trees. While the crude oil was being applied, a very strong wind was blowing making thorough work very difficult. This may have affected the results to a slight degree for a few egg masses here and there were found to have been slighted. In experiment 9, or where the 1 to 12 formula was used, 43 per cent of the eggs failed to hatch.

In the check, 4 per cent only failed to produce worms. In the counts that were made of fruit injury, this 43 per cent killing of unhatched worms made a reduction of only 6 per cent in total fruit losses. On the sprayed plat, 24 per cent of the fruit were damaged while 30 per cent were injured on the control rows.

Nineteen per cent, only, were killed in experiment 10 where the crude oil was used in a dilution of 1 to 15. Here, 26 per cent of the fruit were found to have been injured by the worms as compared with 30 per cent in the check. To have obtained good results, a strength of at least 1 to 8 should have been applied. It is clear that an application in this strength should be made only when the trees are entirely dormant.

The results that were obtained from the miscible oil experiments were highly satisfactory in every way. In fact, the figures show such complete efficiency that those skeptically inclined might look upon them with suspicion. As has been stated before, the miscible oil was applied in four strengths, 5, 6, 7, and 8 gallons to the 100 gallons of water. Owing to the fact that a delay occurred in the receipt of the material, followed by rainy weather, the emulsions were not applied until April 3, at which time the trees—of the Newtown variety—were beginning to send out foliage. This foliage development was sufficient to give the orchard a faint green coloration. In a few cases the leaves about the fruit spurs had unfolded to such an extent as to expose the tips of the fruit buds. The trees were thoroughly sprayed, in fact drenched, five to six gallons being applied to each.

On the day following the spraying, the experiments were carefully gone over; little or no foliage injury was observed. Two days later, however, a large amount of foilage burn was found to have resulted. In experiment 11, where 5 to 100 was used, the injury was of little consequence. In the other experiments, the foliage burn was found to increase in direct proportion with the greater strengths of oil used, reaching a rather alarming condition in experiment 14 where 8 to 100 had been applied. In this plat practically all of the foliage that was exposed dried up and dropped off within a week or two. At first it was thought that many of the fruit spurs were killed; the leaves all dropped away but most of the buds continued to grow and the resulting bloom was almost normal though many of the flowers seemed a little smaller than those on the control trees. These were closely watched and soon after the petals fell many of these smaller ones dropped. Upon examining these weaker flowers, the bases of the stems were found to invariably possess a brown discoloration—in some cases they even seemed burned in much the same manner as that found on the leaves. No other injury to the flower buds was

Table I. Arsenate of Lead

No. of Exp.	Date of Applications	Materials Used	Trees Sprayed	Spray per Tree	Results: Fruit Counted	Sound	Injured	Per cent Injured
1.	1. April 3	Lime-sulfur 1–18			Exp. 1			
		Arsenate of lead 2–50	48	$3\frac{1}{4}$ gal.				
	2. April 14	Lime-sulfur 1–27						
		Arsenate of lead 2–50	48	$3\frac{1}{4}$ gal.	1,022	828	194	18.8
	3. May 1	Lime-sulfur 1–36						
		Arsenate lead 3–50	40	4 gal.	Check 1,048	743	305	29.
	4. May 29	Lime-sulfur 1–30						
		Arsenate of lead 3–50						
	Fruit sprayed only							
2.	1. April 3	Lime-sulfur 1–18			Exp. 2			
		Arsenate of lead 4–50	50	$3\frac{1}{4}$ gal.				
	2. April 14	Lime-sulfur 1–27						
		Arsenate of lead 4–50	50	4 gal.				
	3. May 1	Lime-sulfur 1–36			1,062	900	162	15.
		Arsenate of lead 3–50	50	4 gal.				
	4. May 29	Lime-sulfur 1–38			Check 1,048	743	305	29.
		Arsenate of lead 3–50	50	4 gal.				
	Fruit sprayed only							
3.	1. April 3	Lime-sulfur 1–18			Exp. 3			
		Arsenate of lead 2–50	50	$3\frac{1}{4}$ gal.				
	2. April 15	Lime-sulfur 1–27						
		Only	50	$3\frac{1}{4}$ gal.	1,060	800	2[illegible]0	24.5
	3. May 1	Lime-sulfur 1–36						
		Arsenate of lead 3–50	50	$3\frac{1}{4}$ gal.	Check 1,019	800	279	27.5
	4. May 29	Lime-sulfur 1–38						
		Arsenate of lead 3–50	50	$3\frac{1}{4}$ gal.				
	Fruit sprayed only							
4.	1. April 3	Lime-sulfur 1–18			Exp. 4			
		Arsenate of lead 4–50	50	4 gal.				
	2. April 15	Lime-sulfur 1–27						
		Only	50	4 gal.	1,102	800	302	27.
	3. May 3	Lime-sulfur 1–36						
		Arsenate of lead 3–50	50	4 gal.	Check 1,019	800	279	27.5
	4. May 29	Lime-sulfur 1–38						
		Arsenate of lead 3–50	50	4 gal.				
	Fruit sprayed only							
5.	1. April 3	Lime-sulfur 1–18			Exp. 5			
		Arsenate of lead 6–50	50	4 gal.	1,177	1,017	117	11.
	2. April 14	Lime-sulfur 1–27						
		Arsenate of lead 6–50	50	4 gal.	Check 1,019	800	279	27.5
	3. May 4	Lime-sulfur 1–36						
		Arsenate of lead 3–50	50	4 gal.				
	4. May 29	Lime-sulfur 1–38						
		Arsenate of lead 3–50	50	4 gal.				
	For fruit only							
6.	1. April 3	Lime-sulfur 1–18			Exp. 6			
		Arsenate of lead 6–50	20	4 gal.				
	2. April 14	Lime-sulfur 1–27						
		Only	20	4 gal.	This application was made on Johnathans, a variety which is not nearly as susceptible to roller attack with a result that no comparative counts were made.			
	3. May 4	Lime-sulfur 1–27						
		Arsenate of lead 3–50	20	4 gal.				
	4. May 29	Lime-sulfur 1–36						
		Arsenate of lead 3–50	20	4 gal.				
	For fruit only							

observed. Many of the small buds on the larger limbs which in time would develop into fruit spurs were killed, with a result that in the forming of new buds and the resulting foliage growth, the development of the leaves on the plats seemed several weeks behind that of the checks. Today, however (July 20) little or no visible difference in the amount of foliage and fruit exists between sprayed and check trees. In fact (perhaps my imagination) many of the sprayed trees appear more vigorous and possess a richer green coloration than is found in the checks. Just what effect this burning of the fruit spurs will have on next year's crop is a point of interest that will be watched keenly during this fall and next spring.

By referring to the table, the results that were obtained in the miscible oil experiments will be noted. Egg counts were made to determine the ovicidal properties of the various strengths, and fruit counts were made to determine the percentage of injury caused by the surviving worms. It might be added at this point that the infestation was not as severe in the oil plats as was found to occur in the arsenate of lead experiments though both series were carried on in the same orchard. The only explanation that can be offered is that the Newtown appears to be more resistant to roller attack than the Spitzenburg. Owing to the fact that it was adjudged unsafe to apply the oil to the Spitzenburgs on account of the advanced foliage condition, Newtowns, whose development is more tardy, were substituted. The infestation here was about two thirds as severe as that existing in the arsenate of lead experiments.

All of the miscible oil applications proved to be decidedly efficient as agents in killing the leaf-roller eggs. In checking up the experiments it was found that the numbers of hatching eggs taken from the different plats varied directly with the strengths of oil used. These same variations, though of very narrow margins, were found to exist when the fruit counts were made.

In experiment 11, where 5 gallons to 100 were used, 92.1 per cent of the roller eggs failed to hatch. In the check rows (two rows left across the orchard on either side of which were two experimental plats), 96.8 per cent of the worms emerged. When the countings were made to determine the fruit injury it was found that the worms that escaped the oil caused a 3.6 per cent injury. On the check rows, 18 per cent of the apples were damaged by the worms. In increasing the oil to 6 gallons to the 100 in experiment 12, the efficiency increased from 92.1 per cent to 98.8 per cent. In this experiment, 2.9 per cent of the apples were injured by rollers or a very slight decrease from that noted in number 11.

TABLE II. OIL EMULSIONS

Exp. No.	Material Used	Strength	Date	Gals. per Tree	Results							
					Egg Count				Fruit Count			
					Eggs	Hatched	Killed	Per cent Killed	Fruits	Sound	Injured	Per cent Injured
7.	Kerosene Emulsion 1 tank	1 to 5.6	April 3	5	Exp. 7 1,217 CHECK 862	1,173 817	44 45 failed to	3.6 5. hatch	(Not efficient, no count)			
8.	Distillate Emulsion 1 tank	1 to 5.6	April 3	5	Exp. 8 937 CHECK 862	903 817	34 45 failed to	3.6 5. hatch	(Not efficient, no count)			
9.	Crude Oil Emulsion 1 tank	1 to 12	March 27	5.2	Exp. 9 827 CHECK 923	466 877	361 46 failed to	43. 4. hatch	1,064 CHECK 1,010	800 700	264 310	24. 30.
10.	Crude Oil Emulsion 1 tank	1 to 15	March 27	4	Exp. 10 1,014 CHECK 923	813 877	201 46 failed to	19. 4. hatch	1,091 CHECK 1,010	800 700	291 310	26. 30.
11.	Miscible Oil No. 1 (Balfour Guthrie Co.) 1 tank	5 to 100	April 3	5	Exp. 11 769 CHECK 960	61 929	708 31 failed to	92.1 3.2 hatch	1,038 CHECK 1,045	1,000 850	38 195	3.6 18.
12.	Miscible Oil No. 1 (Balfour Guthrie Co.) 1 tank	6 to 100	April 3	5	Exp. 12 783 CHECK 960	9 929	774 31 failed to	98.8 3.2 hatch	1,030 CHECK 1,045	1,000 850	30 195	2.9 18.
13.	Miscible Oil No. 1 (Balfour Guthrie Co.) 1 tank	7 to 100	April 3	5	Exp. 13 710 CHECK 960	5 929	705 31 failed to	99.3 3.2 hatch	1,028 CHECK 1,045	1,000 850	28 195	2.7 18.
14.	Miscible Oil No. 1 (Balfour Guthrie Co.) 1 tank	8 to 100	April 3	5	Exp. 14 1,006 CHECK 960	4 929	1,002 31 failed to	99.6 3.2 hatch	1,008 CHECK 1,045	1,000 850	8 195	.8 18.

In experiments 13 and 14 the results that were obtained seem to approach the incredulous. The high percentages attained in destroying the eggs is substantiated by the figures that were obtained in counting the fruit for roller injury. In number 13, 99.3 per cent of the eggs were killed and in number 14, out of 1,006 eggs examined, only four hatched. This give a killing percentage of 99.6 per cent. The fruit loss in this last experiment amounted to .8 per cent, eight injured apples being found in examining 1,000.

In summing up the experimental results it is found that efficiency is approached in experiment 5 where lead arsenate is used at the rate of 6 pounds to the 50 gallons of water and obtained in experiments 11 to 14 inclusive where miscible oil was used. In comparing the costs attached to using these materials, the miscible oil must be considered by far the more economical. The lead application costs for materials alone in the neighborhood of $1.65 per tank of 200 gallons. The miscible oil, as used in experiment 12, will cost about $1.50 per tank and, as it cannot be used in combination, the application will be extra. The marked increase in efficiency attained with the oil, however, more than warrants its use. For complete safety to the foliage, the oil applications should be made before the buds burst. Apparently no permanent injury occurred in our experimental plats this season from the late applications, but the margin of safety is extremely small and such a proceedure should not be generally followed.

The author wishes to thank Mr. F. W. Radford and Mr. Frank Davidson for their generous assistance and coöperation which has made possible the conducting of the large series of experiments during the past season.

Vice-President Cooley: Mr. F. C. Bishopp will present the next paper.

A PRELIMINARY STATEMENT REGARDING WOOL MAGGOTS OF SHEEP IN THE UNITED STATES

By F. C. Bishopp and E. W. Laake, *of the Bureau of Entomology*[1]

Introductory

The wool maggots, although pests of importance to sheep raisers, have received practically no attention from investigators in the United States. In Europe, especially in the British Isles, the wool maggot is one of the most serious insect pests of sheep. In Scotland, in partic-

[1] Published by permission of the Chief of the Bureau of Entomology.

ular, every shepherd is familiar with this type of injury, and the watching of the flocks for infested animals and the destruction of the maggots are a part of their routine work. The common green-bottle fly, *Lucilia sericata,* is responsible for the trouble in Great Britain, and also in parts of continental Europe. Only those animals which have the wool considerably soiled with blood, fæces or urine are attacked. This species of fly is abundant in the United States, and, in fact, is almost world-wide in distribution.

The wool maggot assumes much greater importance in Australia than in any other part of the world. This, of course, is due to a considerable extent to the vastness of the sheep industry in that country. Professor W. W. Froggatt [1] states that during a single year the loss due to wool maggots in Australia was conservatively estimated at a million pounds. In that country eight species of flies are found to blow sheep, namely, *Calliphora villosa, C. oceaniæ, C. rufifaces, C. varipes, Lucilia sericata, L. cæsar, Ophyra nigra,* and *Sarcophaga aurifrons.* Professor Froggatt states that until about ten years ago only wounds of sheep were blown, but recently the flies appeared to have acquired the habit of attacking sheep of all classes upon the slightest provocation. In Hawaii another species of Calliphora (*C. dux*) has been reported by Van Dine [2] as causing serious injury to sheep by blowing the soiled wool.

Type of Injury and Species Concerned

In various parts of the United States the infestation of soiled wool on sheep is not uncommon, and in certain sections this is a problem of no little importance. Through the Central States the infestations usually occur in mid-summer and are confined largely to lambs or heavy wooled ewes which have the wool about the rumps soiled from diarrhea, or from being kept in dirty paddocks. A similar condition prevails in the Northwestern States, though infestations are infrequent as far as has been learned. The species of the fly or flies concerned in this injury has not been positively determined, although it is believed that the green-bottle flies, *Lucilia sericata* and *L. cæsar,* are responsible, at least in part.

In southwestern Texas, where the sheep industry is one of large extent, a somewhat different condition prevails. The most acute trouble occurs early in the spring, usually during April. The injury is of two types. First, the infestation of the wool about the rumps

[1] Froggatt, W. W., 1914. Sheep maggot flies in Australia. *Bulletin of Entomological Research,* Vol. 5, Pt. 1, pp. 37–39, April.

[2] Van Dine, D. L. and Norgaard, A. A, 1908. Abstract of a preliminary report on insects affecting live stock in Hawaii. Proc. Hawaiian Live Stock Breeders Assoc., pp. 19–70.

of ewes following lambing, and, second, the blowing of the wool about the base of the horns of rams. Owing to the fact that the sheep in this region receive no shelter during the winter and for the most part are dependent upon the range for food, lambing usually takes place during March and April. If lambing is undertaken earlier than this, the adverse weather conditions often cause considerable losses, and if extended beyond the first of May the screw-worm fly, *Chrysomyia macellaria,* is responsible for enormous losses among the ewes and newly dropped lambs. Showers which fall early in April are often followed by periods of warm, muggy weather and this condition is most favorable for fly attack. Practically all of the rams in western Texas have horns and their infestation is stimulated by slight wounds or bruises about the head which are often produced by fighting. In some cases dehorning is practiced, and, if the horns are not completely healed before the warm weather begins, infestation almost invariably follows.

The infestation of ewes is largely confined to the rump. Although the flocks are divided up considerably and each group is under the care of a herder, often the infestation proceeds for some time before it is noticed. At first the maggots confine their attack to the matted hair, usually working close to the skin. The inflammation produced soon results in the complete denudation of the portions attacked and the production of highly inflamed and practically raw areas. The maggots continue to spread into the adjacent wool from these centers and in many cases, if not destroyed, also penetrate the skin and soon cause the death of the sheep. In order to remove the infestation it is sometimes necessary to shear large areas in addition to the loss of wool caused by the larvæ themselves.

In the case of infested rams, the larvæ work for some little time immediately around the base of the horns. The condition produced extends the favorable breeding places, and in many cases the larvæ enter the ears and there produce additional complications. Infested sheep rapidly fall off in condition and soon refuse to eat. This reduces the milk supply of the ewes which sometimes results in the death of the lambs. It is stated by men who make a business of rearing rams that some years as high as one third of the rams in the state of Texas are lost on account of maggot and screw-worm infestations. The conditions produced by the wool maggots when infestations take place late in the spring frequently induce the attack of screw-worms.

Investigations conducted by the writers, during the spring of 1915, showed that the common black blow-fly, *Phormia regina,* was responsible for infestations in both of the above-mentioned places of attack. So far as the writers are aware, this is the first record of this species attacking soiled wool of sheep.

Some wool maggot infestations take place in western Texas during mid-summer and early fall, especially after the wool begins to get fairly long following the spring shearing. It is thought that *Lucilia sericata* is probably mostly concerned in these attacks although specimens have not been reared. Phormia is entirely absent or very scarce during mid-summer in Texas as will be discussed later, hence it could not be the culprit in this instance.

Seasonal History of *Phormia regina*

This species is widely distributed in the United States. It shows considerable differences in seasonal history in different sections of the country. In the Southern States the fly is active throughout the winter, although it may disappear for a few days during cold periods. It usually reaches its greatest abundance in the early spring, diminishing as hot weather comes on. During hot, dry seasons, in particular, the adults are not to be found in nature during June, July and August, although at Dallas, Texas, we have succeeded in keeping them breeding in cages throughout the summer. In the northern part of the country the fly is, of course, absent during the coldest weather, but is to be found in large numbers during the spring and fall, and in the extreme north is abundant throughout the summer. At Dallas, Texas, we have kept the species breeding throughout the winter, and it is not uncommon to find carcasses in nature which are literally swarming with maggots of this species during mid-winter. During the coolest weather the development is materially retarded, especially in the pupal stage. It is therefore most probable that in northern latitudes the insect passes the winter in the soil either in the pupal or pre-pupal condition.

Some rather interesting observations on the wintering of *P. regina* as compared with *Lucilia sericata* and other flies, including the screw-worm fly, *Chrysomyia macellaria,* were made on material collected on carcasses or butchers' offal in the autumn of 1914. One large lot of larvæ collected on offal on October 28, 1914, was fed on meat placed on sand at the laboratory in Dallas. Many were migrating during the nights of October 29 and 30 and many had pupated November 2. *P. regina* and *C. macellaria* began emerging November 14. Emergence in large numbers continued till the end of the month when adults of *C. macellaria* became few, *P. regina* continued to appear in good number till December 9, when emergence ceased entirely. On this date adults of *Lucilia sericata* began to appear, but all emergence stopped during the cold weather, until February 8, when *L. sericata* again began emerging and continued to appear more or less regularly up to April 15. The maximum emergence of *L. sericata* occurred about

the middle of March. Five specimens of *Sarcophaga* sp. emerged, these appeared on March 30, April 2, 10, 13 and 15.

Other large supplies of larvæ and pupæ collected in the fall showed very similar results as regards emergence; the adults of *P. regina* emerge when the temperatures are moderate in fall and spring but the Lucilias do not appear till later in the spring.

The seasonal occurrence of infestations of *P. regina* in Texas appears to range from the beginning of lambing, which is about December 1, to shearing time. Shearing is begun in April and extends to June, the ewes being the last to be shorn. The cessation of injury in early summer is due to the dimunition of the number of Phormia and more especially to the abolition of favorable places for attack by the removal of the wool.

Life-History and Habits of *Phormia regina*

So far as we have observed, *Phormia regina* breeds exclusively in animal matter or in substances in which animal matter is intermixed. The species is found very generally distributed where it normally occurs. Specimens have been observed far from any habitation, and it is also very commonly met with in the center of large cities. While the flies visit freshly killed animals and fresh blood, they show a special predilection for meat which is in a decaying condition and consequently having a strong odor. It is probably the odor of the soiled wool, especially when some blood is present, which attracts the flies to the living sheep. This species has been observed to breed in large numbers in the paunch contents of cattle which has been more or less saturated with blood during slaughtering. They do not deposit eggs in this material if no blood is present.

Under range conditions it has been found that carcasses of large domestic animals are responsible for the vast majority of flies present. During the fall, winter and early spring probably nine-tenths of the flies which breed in carcasses are of this species. Small wild animals and birds also supply favorable breeding places.

The adults feed freely on various substances but are especially attracted to juices from animal matter. They are rarely observed on fecal matter if no blood or animal tissue is present. Human fæces and excrement of hogs are much more frequently visited than droppings of herbiverous animals.

In cages ranging up to 10 x 10 x 6 feet, flies were found to require from six to eighteen days after emergence before oviposition began. The adults show a marked tendency to deposit their eggs in large masses. This tendency is more noticeable than in other meat-infesting species. Hatching takes place in less than twenty-four hours up

to about four days. Eggs deposited on living animals probably hatch in eight or fourteen hours. The larvæ complete their growth in from four to seventy-six days, and shortly before pupation show a marked tendency to migrate from the material upon which they have been feeding. They usually enter the ground, sometimes to a depth of three or four inches, but some pupæ may be found under loose objects lying on the surface of the soil. The pupal stage ranges from three days to over a month. The larvæ and pupal periods are shortened somewhat as the mean daily temperature increases but excessively hot weather is detrimental to breeding, apparently, however, affecting the adults even more than the immature stages.

The total developmental period ranges from nine to at least seventy-six days.[1] Dr. E. P. Felt,[2] working at Nassau, N. Y., records the duration of stages in this species as follows: Egg stage, 8 to 24 hours; 1st larval stage, about 3 days; 2d larval stage, 2 to 3 days; 3d larval stage, active feeding period, 3 days; period from entrance into soil to first adult emergence, 14 days. Thus about twenty-three days were required for the cycle from egg to adult. The accompanying table includes some of our data on developmental periods.

TABLE I. DEVELOPMENTAL PERIODS OF *Phormia regina* AT DALLAS, TEXAS

Date Eggs Deposited	Date Hatched	Incubation Period	Dates of Pupation		Larval Period	Dates adults emerged		Pupal Period	Total Developmental Period
			First	Last		First	Last		
1914		Days			Days			Days	Days
Apr. 11, 3 p.m.	Apr. 15, 10 a.m.	$3\frac{3}{4}$	Apr. 24	Apr. 29	9 to 14	May 2	May 5	8 to 11	21 to 24
Apr. 14	Apr. 15, p.m. or Apr.16,a.m.	1 or 2	Apr. 25		9 or 10	May 4	May 5	9 to 10	20 to 21
May 24–25	May 26	1 to 2	May 31	June 3	5 to 8	June 6	June 8	6 to 8	12 to 15
May 18	May 19	1	May 27	May 29	8 to 10	June 3	June 5	7 to 9	16 to 18
May 27	May 28	1	June 1	June 3	4 to 6	June 8	June 10	7 to 9	12 to 14
June 19	June 20	1	July 24		4	July 28		4	9
June 8	June 9	1	June 13	June 16	4 to 7	June 19	June 20	6 to 7	11 to 12
Sept. 19	Sept. 20	1−	Sept. 28	Sept. 29	8 to 9	Oct. 5	Oct. 8	7 to 8	16 to 19
Oct. 22	Oct. 23	1±	Nov. 11	Nov. 20	19 to 28	Dec. 4	1915 Jan. 6	23 to 56	43 to 76
	Dec. 19[1]		1915 Feb. 12	1915 Mar. 5	55+ to 76+	1915 Mar 5 to 29		21 to 45	76+ to 90±
1915	1915								
May 18	May 19	1±	May 25	May 27	6 to 8	May 31	June 1	6 to 7	13 to 14

[1] Larvæ from one-half to full grown collected on date.

[1] The developmental periods of *P. regina*, *Lucilia sericata* and *L. cæsar* as compared with several other meat-breeding flies are summarized by one of the authors (Bishopp) in the JOURNAL OF ECONOMIC ENTOMOLOGY, VIII, pp. 325–329, 1915.

[2] Felt, E. P., 1913. Bull. 165, N. Y. State Museum, pp. 75–79, pls. 3–6.

When caged without food the longevity of the adults is rather short, ranging from two to eight days. Supplied with suitable food and meat upon which to deposit they have been observed to live as long as ninety-three days in winter and thirty-one days in April and May. The longevity decreases as hot weather approaches.

Seasonal History of *Lucilia sericata*

This species is to be seen through the year in the Southern States except in the coldest periods in winter. It is not so plentiful, however, in late fall, early spring and in warm periods in mid winter as is *P. regina*. Reproduction does not often take place in winter even in the extreme South. The adults are present throughout the summer though then often diminish in numbers during excessively hot dry periods. In Texas the winter is passed in the larval and pupal stages in the soil or beneath carcasses. It is almost certain that in the North, also, the same condition prevails. Attempts to get the adults to pass the winter in cages have been unsuccessful. Some information regarding wintering is given under the discussion of the seasonal history of *P. regina*.

Life-History and Habits of *Lucilia sericata*

This species has a wide distribution in North America. It is more closely associated with human habitations than *P. regina* or *C. macellaria*, being very common in back yards and in alleys even in large cities. It is seldom seen on the range and in pastures far from houses. Garbage, including all sorts of kitchen refuse, is attractive, and damaged fruit is a favorite food for the adults. The flies are not infrequently seen in dwellings and often collect in great numbers under ornamental vines and beneath the leaves of vegetables, especially cucumbers and melons. They visit flowers to some extent and are strongly attracted to honey-dew on plants.

We have not succeeded in securing depositions or rearing larvæ on other substances than animal matter. Eggs are freely deposited on raw or cooked meats in various stages of decay and on carcasses of all kinds. As has been stated, this is the species responsible for maggoty wool in Great Britain and doubtless is the principal cause of cases of blown sheep which occur in mid-summer in this country. Mr. H. F. Hudson[1] has recently reported an instance in Ontario in which a calf suffering from white scours became infested around the vent by this green-bottle fly. Two cases have been observed by the senior author in which tame rabbits, having injuries on their backs from fighting, became infested and were ultimately killed by maggots of this species.

[1] Hudson, H. F., 1914. *Canadian Entomologist* 46, p. 416, December.

The longevity of the adults when kept without food is very short, from one to three days. When supplied with suitable food, we have observed a longevity of ten to forty days. The period from emergence of the adults to the beginning of egg-laying ranges from four to twenty-one days. Incubation varies much with the temperature, usually slightly less than twenty-four hours are required, but somewhat shorter periods have been observed, and the maximum incubation period which we have noted is seven days. The developmental periods are shown in the accompanying table.

TABLE II. DEVELOPMENTAL PERIODS OF *Lucilia sericata* AT DALLAS, TEXAS

Date Eggs Deposited	Date Hatched	Incubation Period	Dates of Pupation		Larval Period	Dates Adults Emerged		Pupal Period	Total Developmental Period
			First	Last		First	Last		
1913	1913	Days	1913	1913	Days	1913		Days	Days
July 28	July 29	1–	Aug. 3		5	Aug. 8		5	11
Aug. 16	Aug. 17	1–	Aug. 26		9	Aug. 31		5	15
1914	1914		1914	1914		1914	1914		
Sept. 4	Sept. 5	1–	Sept. 9	Sept. 10	4 to 5	Sept. 14	Sept. 17	5 to 8	10 to 14
				1915			1915		
Oct. 21	Oct. 22	1	Nov. 5	Mar 15	14 to 144	Dec. 21	Apr. 18	46 to 164	61 to 179
						1915			
Oct. 22	Oct. 23	1±	Nov. 11	Apr. 5	19 to 164	Apr. 10	Apr. 22	150 to 162	170 to 182
						1914			
Oct. 24	Oct 25	1±	Nov. 11	Apr 5	17 to 162	Dec. 5	Apr. 22	24 to 162	42 to 180
			Before	After		1915			
Oct. 29	Oct. 30	1+	Feb. 11	Mar 5	104– to 126+	Apr. 6	Apr. 19	54 + to 67	159 to 172
				After					
Nov. 1	Nov. 2	1±	Nov. 17?	Mar. 5	15 to 123	Mar. 17	Apr. 15	121? to 149?	137 to 166
1915	1915		1915						
Apr. 24	Apr. 25	1±	Apr. 30	May 3	5 to 8	May 10	May 20	10 to 20	16 to 26
Apr. 25	Apr. 26	1±	May 1	May 6	5 to 10	May 14	May 17	13 to 16	19 to 22
Apr. 26	Apr. 27	1±	May 2	May 14	5 to 17	May 13	May 20	11 to 18	17 to 24
Apr. 27	Apr. 28	1–	May 5	May 14	7 to 16	May 15	June 5	10 to 31	18 to 39

SUGGESTIONS REGARDING CONTROL

In this preliminary paper it is not desired to discuss at length various means of repression which may be of value, but a few of the principal points will be touched upon. In order to mitigate the injury due to these species it is essential that greater care be exercised in destroying carcasses of animals. These should be burned as soon as possible after death. In case of shortage of fuel it is sometimes more feasible to bury carcasses, especially of small animals. Preliminary experiments with the burial of carcasses indicate that under most conditions it is necessary to cover an infested animal with two feet of earth in order to prevent the flies from emerging. If an animal is buried before infestation takes place, a few inches will suffice to protect it from infestation.

The treatment of carcasses with borax and certain other chemicals has given fair results but is not as satisfactory as burning.

To prevent infestation of sheep following lambing it is desirable that lambing be done during the winter whenever practicable. In some cases this will necessitate changes in range practices, including the feeding of ewes and furnishing shelter for them. Where lambing is done during weather which is conducive to fly breeding, it is important that the flocks be divided into fairly small units and carefully watched. In exceptionally bad seasons, the systematic trimming of the soiled wool from between the legs and around the vent of the ewes is a good preventive. An effort should be made to keep the sheep in strong, healthy condition and avoid scouring. No doubt dipping the rumps of sheep in repellant solutions will also prove beneficial although some damage to the wool would usually result. Investigations along this line have not been completed.

It is very desirable that strains of hornless sheep be developed for use throughout the United States, especially in regions where wool maggots and screw-worms occur in numbers.

In treating infested sheep it is important to trim the wool away so as to allow the insecticide used to thoroughly reach the maggots, and to lessen the danger of reinfestation. The trimming should be begun around the outside of the infested area so as not to drive the maggots back into the clean wool. Concoctions containing a considerable percentage of chloroform have been found effective in destroying the maggots. It is advisable to add a small quantity of oil of tar to the material used to act as a repellant for the flies.

A hymenopterous parasite, presumably *Nasonia brevicornis* Ashmead, has been found to breed freely in the puparia of a number of carrion infesting flies, including *P. regina* and the two species of Lucilia. As many as thirty-five parasites have been observed to develop within one puparium. Ten puparia of a species of Sarcophaga exposed to parasitism produced 343 adult parasites. The developmental period at Dallas as observed by the junior author ranges from nineteen days upwards. Considering the comparatively short period required for development and the reproductive capacity of an individual parasite, this species is to be looked upon as an important natural check to fly-breeding. Often where the puparia are concentrated, as around a carcass, a high percentage of parasitism results. Other parasites have been reared but this one is most important.

Vice-President Cooley: The next paper will be presented by Mr. E. D. Ball.

FIELD NOTES ON GRASSHOPPER OUTBREAKS

By E. D. Ball, *Logan, Utah*

(Withdrawn for publication elsewhere.)

Adjourned 4.30 p. m.

Morning Session, August 10, 1915

The session was called to order at 10.15 a. m. by Vice-President Cooley.

Vice-President Cooley: The first paper will be read by Mr. C. E. Pemberton.

THE EFFECT OF COLD STORAGE TEMPERATURES UPON THE EGGS AND LARVÆ OF THE MEDITERRANEAN FRUIT FLY

By E. A. Back and C. E. Pemberton, *Honolulu, T. H.*

(Withdrawn for publication elsewhere.)

Vice-President Cooley: The next paper is by Mr. A. L. Melander.

VARYING SUSCEPTIBILITY OF THE SAN JOSÉ SCALE TO SPRAYS[1]

By A. L. Melander, *Pullman, Wash.*

There seems to be no doubt but that sulphur-lime has ordinarily been a most efficient scalecide. In the arid region at Wawawai, Washington, Piper twelve years ago was able to announce complete destruction of the San José scale in one to two weeks after the application. Similar quick results have been observed in recent years with scales from Wenatchee. On the other hand, this insect is becoming increasingly prevalent in some of the older fruit sections of Washington, notably at Clarkston, and a critical investigation shows that not only are the scales slow to succumb to the effects of sulphur-lime but that there is a pronounced and great individual difference, many scales manifesting even a complete immunity to this insecticide.

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[1] Contribution from the Zoölogical Laboratory of the State College of Washington.

After witnessing encrusted scale insects surviving a bath ten times normal strength, or others still alive and growing after three biweekly sprayings of a stronger than usual sulphur-lime, one cannot agree with the statement that the prevalence of the insect is due to faulty application. It must be due in part at least in these cases to an inherent vigor of the insect to withstand the toxic effects of the spray. To determine the range of individual susceptibility to this and other sprays and to ascertain the proportion of immune individuals, and thus to measure the biological difference in scales from several localities, the Washington Experiment Station some years ago instituted a series of experiments in which identical solutions were sprayed at selected places. The results of the tests of 1913 were reported at the Atlanta meeting of the Association of Economic Entomologists and were published in the Journal of Economic Entomology for April, 1914.

It is the purpose of this paper to announce the results obtained this year, which, while corroborating the previous seasons' tests, show even a greater range in susceptibility among the scales from various localities.

The plan of the experiment took as a standard three-degree factory-made sulphur-lime, comparing this with both stronger and weaker sprays and checking against oil emulsions as well as against no spraying at all. The sulphur-lime concentrate tested thirty-four degrees Beaumé and was made at the Petrie plant at Clarkston. This was diluted for tests at five degrees, three degrees and two degrees. Thomson's Orchard Brand oil emulsion at 5 per cent strength was used as in the tests of the two preceding years. Owing to difficulty in emulsifying crude oil with the liquid soap at hand the results with this insecticide were not promising and will be neglected in the present discussion. A sulphur-soda spray known as Soluble Sulphur also was used at each place made up in concentrations equivalent to the sulphur-limes used. For comparison with the tests made in preceding years the spraying was done at Clarkston, Walla Walla, Sunnyside, North Yakima and Wenatchee, although different trees were used at all the places except Sunnyside. Apples were used throughout the experiments.

The applications were given just previous to the swelling of the buds, a narrow cylinder bucket pump and Bordeaux nozzle being employed. The selected branches were more than drenched with a driving spray so as to avoid the possibility of missing any individuals. Whenever there was any danger of the spray drifting to other selected branches the parts being treated were isolated by large cloth sheets previously rendered water-proof by immersion in a gasoline solution of mutton tallow.

At intervals of two or three weeks, sample branches were pruned from each test and the condition of the sprayed scales was noted by dissection under the prism binocular microscope. The numbers of living and dead scales were recorded by means of a pair of tally registers operated by the examiner's feet. Here, naturally, enters the personal element in forming a decision in the case of dying or just dead scales. Practically all the counts were made by A. L. Melander and M. A. Yothers checking against each other from different samples of each test, and in the following tabulations the percentages given are the average of their two counts. Not only is it extremely difficult, if not impossible, to decide just when a scale insect dies, but the last counts were further vitiated by certain scales dropping from the branches. This seemed to be particularly true where the stronger sulphur sprays were used, and forms a factor that should not be neglected when discussing the insecticidal properties of these sprays. It seems that a polysulphide spray changes the waxy covering so as to render it difficult for the awakening scale to attach its spring secretions. Thus in some instances the body of the insect grows beyond the scale-covering, loosening and raising it from the plant epidermis so that ultimately it falls off. Such unprotected individuals perish and drop from the branches. While this mode of death is more or less of a factor in sulphur-lime treatment, yet it is not of great importance unless the spray is used unduly strong.

Sulphur-lime is supposed to kill principally by chemical suffocation, due to its strong affinity for oxygen. During the reaction the protoplasm of the insect changes in appearance, becoming viscous and in color luteous yellow until further change darkens the protoplasm to a brown and changes its consistency to an oily meal. Just when the transition point occurs where this reaction ceases to be reversible and death ensues is unknown, but in interpreting results the insect at the viscous, luteous stage is considered dead. During warm weather the moisture of the protoplasm quickly disappears as soon as the insect dies, and hence when scales die from the first shock of deoxygenation, their dead condition can be interpreted within a few days or weeks. Furthermore, in making these counts, only the small blackish overwintering scale insects are considered, since overwintering adults are of extremely rare occurrence. After the males had emerged, their empty shells were rated as living insects in order not to disturb the balance of the sexes at the last count. Whatever element of uncertainty might appear in making determinations of doubtful cases is largely offset by the large numbers counted, for during the season over 170,000 scales were individually dissected from the branches and their condition recorded.

Wenatchee

In previous years sprays used at Wenatchee have shown their final value within two weeks' time. This year the first counts, twenty days after the application, showed about 40 per cent of the individuals still in living condition whenever sulphur sprays were used. Oil prayed insects after the same interval were completely killed. The second count, however, thirty-seven days after spraying, uniformly showed practical extermination, only 1 to 3 per cent of the scales being rated as alive. This was also the condition recorded at the final count, twenty-four days later. The following tabulation briefly gives the proportion of living insects at the successive counts:

	20 days	17 days	24 days
Sulphur-lime, 5°	45%	2.3%	1.4%
Sulphur-lime, 3°	34	0.8	1.6
Sulphur-lime, 2°	48	3.	2.2
Sulphur-soda, 2°	50	1.1	1.8
Oil, 5%	0	0	0
Check	53	67	45

North Yakima

Tests of 1914 carried on by M. A. Yothers indicated that the San José scale at North Yakima died about as slowly from the effects of sulphur-lime spraying as at any of the other places of the circuit. This year the first counts, twenty-one days after the application, showed about 50 per cent of the insects still alive. The second count hovered around 20 per cent, and the third around 10 per cent. The several proprietary oil sprays used gave much more rapid and effective results, practically exterminating the insects by the twentieth day.

	21 days	19 days	12 days	30 days
Sulphur-lime, 5°	36%	19%	4%	10%
Sulphur-lime, 3°	49	17	2	3
Sulphur-lime, 2°	35	31	3	8
Sulphur-soda, 3°	45	26	9	25
Sulphur-soda, 2°	58	24	8	24
Oil, 5%	1	1	0.2	0
Check	88	83	67	74

There is some uncertainty as to the best time to apply sulphur-lime. The general custom in Washington does not call for fall spraying, but formerly applications in early February or late January were in vogue. The tendency is to postpone this spraying, possibly due to the influence of the introduced budmoth and twig-borer which require later spraying, until now the winter application is not begun

until the middle of March and is continued into April, in some instances deferred even until the trees are coming into leaf. Accordingly, in order to obtain critical evidence bearing on this problem certain treatments were repeated on March 26, nineteen days after the original tests were given. While the information they afford is not conclusive, these tests indicate that later sprayings are much less dependable than the earlier. The insects die in both cases at about the same rate during the weeks immediately following the spraying, but when growth sets in there is a larger proportion of survivors in the case of late spraying and these individuals, no longer subject to the action of the weathered spray, are able to negative the effects of the spraying. The following tabulation shows what a large proportion of scales are able to withstand a late application at North Yakima:

	21 days	12 days	29 days
Sulphur-lime, 3°	28%	22%	26%
Sulphur-lime, 2°	29	47	49
Sulphur-soda, 3°	41	38	48
Sulphur-soda, 2°	44	43	43

Walla Walla

Sulphur-lime has been used at Walla Walla probably as long as anywhere in the northwest and if its influence is selective, hardy scales should be expected to occur here. The tests with the same materials that were used at the other stations gave uniformly poor results in the case of sulphur sprays but the oil spray again afforded complete and rapid extermination. It should be noted that by the time of the final examination the male insects had long since emerged and the females were gravid with young.

	20 days	15 days	20 days
Sulphur-lime, 5°	49%	35%	34%
Sulphur-lime, 3°	48	28	27
Sulphur-lime, 2°	57	37	27
Sulphur-soda, 3°	36	28	32
Sulphur-soda, 2°	53	42	36
Oil, 5%	1	0	0
Check	92	89	72

Clarkston

Clarkston at the present time is probably as badly over-ridden with San José scale as any fruit district. The destruction wrought by this insect is almost inconceivable: cherry and peach trees are dying throughout the lower part of the flat and the apple and pear crop is so badly specked with scale as to be unmarketable. Conditions in the adjacent district, Vineland, higher in elevation, are not nearly

so bad, however, While part of the infestation, here as elsewhere, is unquestionably due to faulty application, inefficient methods cannot be blamed for everything. The spraying tests below recorded were carried out thoroughly. The weather was ideal and the insects were drenched with liquid. Nevertheless none of the sulphur sprays afforded anything like satisfactory control and this year even the Orchard Brand of oil failed to give its usual complete success. Unquestionably under conditions like this, sulphur-lime as well as other sulphur sprays should be abandoned in favor of other materials having different insecticidal properties.

	20 days	15 days	15 days	20 days
Sulphur-lime, 10°	65%	41%	28%	43%
Sulphur-lime, 5°	35	41	39	45
Sulphur-lime, 3°	92	59	45	45
Sulphur-lime, 2°	69	63	61	32
Sulphur-soda, 3°	86	51	67	29
Sulphur-soda, 2°	97	72	67	46
Oil, 5%	7	5	3	3
Check	89	98	94	55

This investigation has shown that differences in results from spraying are due to locality rather than to the strength of the solutions used. There is a much greater variation in the effectiveness of the three degree sulphur-lime comparing Wenatchee and Clarkston than there is when comparing a two-degree with a ten-degree sulphur-lime used at Clarkston alone. This contrasting difference between Wenatchee and Clarkston cannot wholly be ascribed to climate, nor to the condition of the trees, nor to the water used in diluting the sprays, nor to comparative thoroughness of application, nor apparently to any combination of extrinsic factors. The prevalence of scale at Clarkston and its scarcity at Wenatchee where effective spraying has kept it in complete control, further bear out the supposition that there is an inherent biological difference in the insects of the two places.

Vice-President Cooley: Could you find no other cause than heredity for the resistance to treatment?

Mr. A. L. Melander: That is the only cause that has been determined thus far.

Mr. S. W. Foster: In comparing treatment on different trees, the weather conditions should be similar at the time parallel tests are made. A variation of a week's time in doing part of the spraying might give quite different results.

Mr. A. L. Melander: In the tests mentioned the weather conditions were as near similar as possible.

Mr. F. C. Bishopp: Was there a record of the previous treatment that had been applied to the orchards mentioned?

Mr. A. L. Melander: We have a record for ten years in the orchard at Charleston, where 5 per cent to 10 per cent survived treatment. In some cases we got as good results with a weak as with a heavy spray. In some cases from 20 per cent to 50 per cent of the insects survived treatment.

Vice-President Cooley: The next paper will be read by Mr. H. F. Wilson.

THE TOXIC VALUES OF THE ARSENATES OF LEAD

By H. V. Tartar, *Chemist*, and H. F. Wilson, *Entomologist, Oregon Agricultural College Experiment Station*

For several years investigations have been carried on at the Oregon Agricultural Experiment Station to determine the relative insecticidal values of the different insecticides in common use. The problems taken up have involved both chemical and entomological work and the data obtained show some very interesting results. Among other things the work done has shown that there are two different arsenates of lead present in the commercial material and that they are quite variable in their action and efficiency. We designate these compounds as lead hydrogen arsenate (acid) and basic lead arsenate (neutral) and experiments made, using both substances in a pure state, show that the first is quicker acting than the second and apparently more efficient in strengths containing equal amounts of arsenic. The data presented in this paper deal with experiments conducted to determine the comparative toxic value of these compounds.

Considerable difficulty was experienced in securing a satisfactory agent for the determination of these toxic values. Very few insects were found to occur in desirable numbers and all of them are present only for a more or less limited period. Of these the common tent caterpillar, *Malacosoma pluvialis* Stretch, was found to offer the best means. This species occurs gregariously in colonies of a hundred or more individuals and during the months of April, May and June large numbers of the larvæ are available. They also feed on all kinds of foliage and eat greedily so that the poison is easily fed to them.

The general plan of the work was to cover the leaves of the twigs with the arsenates in different strengths; then, by the use of some insect which would feed on the foliage, to determine the comparative killing properties and finally to determine by chemical analysis the exact quantity of arsenic consumed.

The Experiments

An effort was made to use a certain set number of larvæ for each experiment but this was found to be unsatisfactory as the individuals clung to the nests and were frequently injured in handling. The next best method was to remove all the foliage from one or more tents and then to fasten the tents to the twigs. In a short time the caterpillars migrated to the leaves and began feeding.

Two sets of experiments were carried on to secure an even coating of the poison on the leaves. In the first set the poison was weighed out and placed in an aquarium jar with the water. This mixture was thoroughly agitated and two small apple twigs were then immersed in the suspension and placed in bottles of water to prevent wilting. In the second set the poison was applied as a spray by means of an ordinary glass hand-sprayer. No difference could be noted in the apparent amount of poison present on the leaves by either of these means of application. As soon as the foliage became dry the caterpillars were placed on the twigs.

Each morning following, the dead larvæ, measuring near an inch in length, were gathered, counted, and placed in glass bottles. At the conclusion of the experiments these samples were analyzed for arsenic content.

The following strengths were used:

Series I

2 to 50 gallons of water	(L.H.A. and B.L.A.[1])	10.3 grams to 2000 cc. H_2O
2 to 100 gallons of water	(L.H.A. and B.L.A.)	5.18 grams to 2000 cc. H_2O
2 to 200 gallons of water	(L.H.A. and B.L.A.)	2.59 grams to 2000 cc. H_2O
2 to 400 gallons of water	(L.H.A. and B.L.A.)	1.295 grams to 2000 cc. H_2O
2 to 800 gallons of water	(L.H.A. and B.L.A.)	.6475 grams to 2000 cc. H_2O

The first three sets were applied April 22, the other two April 23, 1915.

Series II

2 to 50 gallons of water	(L.H.A. and B.L.A.)	2.59 grams to 50 cc. H_2O
2 to 100 gallons of water	(L.H.A. and B.L.A.)	1.281 grams to 50 cc. H_2O
2 to 200 gallons of water	(L.H.A. and B.L.A.)	.647 grams to 50 cc. H_2O
2 to 400 gallons of water	(L.H.A. and B.L.A.)	.3237 grams to 50 cc. H_2O
2 to 800 gallons of water	(L.H.A. and B.L.A.)	.1618 grams to 50 cc. H_2O
2 to 1200 gallons of water	(L.H.A. and B.L.A.)	.1067 grams to 50 cc. H_2O

The first series was applied May 5; the other five May 4.

The larvæ were gathered each day from paper placed under the vessels containing the twig. The data obtained are tabulated as follows:

[1] L.H.A. = Lead Hydrogen Arsenate; B.L.A. = Basic Lead Arsenate. The former contains approximately 33 per cent arsenic oxide, the latter 25 per cent.

Series I

No.	Strength and Kind of Spray	Applied	Drop April 24	April 25	April 26	April 27	April 28	April 29	Total Drop
1	2:50 L.H.A.	Apr. 22, 1915	325	46	30	20	24	..	445
	2:50 B.L.A.	Apr. 22, 1915	12	17	98	48	30	..	205
2	2:100 L.H.A.	Apr. 22, 1915	56	101	94	51	39	..	341
	2:100 B.L.A.	Apr. 22, 1915	..	7	23	82	57	33	202
3	2:200 L.H.A.	Apr. 22, 1915	46	60	103	121	33	9	371
	2:200 B.L.A.	Apr. 22, 1915	..	5	6	40	101	68	220
4	2:400 L.H.A.	Apr. 23, 1915	..	..	88	57	104	83	332
	2:400 B.L.A.	Apr. 23, 1915	..	..	14	42	57	88	201
5	2:800 L.H.A.	Apr. 23, 1915	..	..	43	110	177	88	418
	2:800 B.L.A.	Apr. 23, 1915	..	..	3	43	108	137	291

Series II

No.	Sprays	Date Applied	May 5	May 6	May 7	May 8	May 9	May 10	May 11	May 12	May 13	Summary Total
1	AL 2:50 L.H.A.	May 5		21	103	83	69	36	33	5	2	352
	AL 2:50 B.L.A.	May 5		3	128	169	53	201	126	66	38 (all dead)	784
2	AL 2:100 L.H.A.	May 4	9	45	69	95	3	19	...	..	..	240
	AL 2:100 B.L.A.	May 4	..	6	17	108	19	41	...	..	..	191
3	AL 2:200 L.H.A.	May 4	65	123	209	118	31	107	...	..	..	653
	AL 2:200 B.L.A.	May 4	..	12	77	139	34	75	46	20	..	453
4	AL 2:400 L.H.A.	May 4	19	77	154	192	44	85	33	..	..	604
	AL 2:400 B.L.A.	......	..	5	21	87	65	42	34	30 (20 more or less alive)	..	284
5	AL 2:800 L.H.A.	......	5	61	106	175	59	97	30	35 (several alive)		568
	[1]AL 2:800 B.L.A.	......	..	3	12	49	21	36	25	6	..	152
6	AL 2:1200 L.H.A.	......	..	12	36	163	115	77	42	93 (picked off)	(a few alive) 23	561
	AL 2:1200	......	..	..	7	23	44	39	46	42 (picked off)	22	223 (at least 25 feeding on first foliage)

[1] Where strengths of 1 to 1200 were used it was necessary to add a second set of sprayed twigs as caterpillars ate all foliage on first set.

Observations

Notes taken during the course of the experiments show very clearly and conclusively that the lead hydrogen arsenate is quicker acting than the basic salt and that smaller amounts are required for killing efficiency. Also, that although the caterpillars on the experiments sprayed with the basic form lived longer, they finally died, and with strengths where less than 2 lbs. to 200 gallons was used the damage done before they died was not serious. These experiments further show that the killing efficiency is reduced in proportion to the reduction of the amount of material used, and that beyond certain strengths they lose their destructive value because the caterpillars cause very serious damage before the quantity of poison eaten is large enough to kill.

A comparison of the efficiency values shows that the lead hydrogen arsenate in strengths of 2 to 50 was quicker acting than the basic, but the results obtained with the latter were satisfactory in that practically the same amount of foliage was eaten in both cases. In strengths of 2 to 100 the difference in action was greatly in favor of the lead hydrogen arsenate but only a slight difference was noticed in the amount of foliage destroyed.

In strengths of 2 to 200 similar conditions were noticed, but with the basic lead arsenate the amount of foliage destroyed was increased. In strengths of 2 to 400 both materials acted more slowly and a considerable part of the foliage was eaten on the basic lead arsenate experiment. The lead hydrogen still remained satisfactory.

In strengths of 2 to 800 practically the same conditions existed, the poison acted slower and the amount of foliage eaten increased.

In strengths of 2 to 1200 neither form prevented serious damage and with the basic form the first twigs were completely defoliated and a second set partly destroyed. As shown in the table these experiments were discontinued before all the caterpillars died because it was not thought necessary to carry them further.

Further comparisons showed that the lead hydrogen arsenate 2 to 200 was more efficient than the basic 2 to 100 and that the lead hydrogen arsenate 2 to 400 was more efficient than the basic 2 to 200 in the protection of foliage.

In the tables it will be noted that as a rule only a few died the first day or two, the heaviest drop occurring within two or three days. This may be accounted for in several ways.

A few caterpillars begin feeding immediately upon being transferred. These are usually quite hungry and eat considerably before stopping. The others feed later at a time more or less regular to their habits and eat according to their hunger, some eating rapidly and devouring considerable foliage before the poison can act. Others eat only a small amount or eat slower and although they become sick they manage to survive for a longer period in proportion to the amount eaten. The behavior of the poisoned caterpillars is practically the same in all cases but varies considerably with the amount eaten. Usually those that are slightly sick wander around to a more or less extent but do not feed and if possible they will leave the twigs. Those with larger doses cluster together and gradually become sluggish, being at first sufficiently active to move the head and forepart of the body from side to side when disturbed. Later they barely move and finally may drop off or remain suspended from the tent by the prolegs.

Chemical Analyses

The chemical analysis of the poisoned caterpillars from each of the tests was made by first drying at 100 degrees centigrade to get the actual weight of the dry tissue of the insects. Then the arsenic was determined in the following manner: A quantity of the dried tissue, not exceeding 4 grams, was introduced in a Kjeldahl flask, 500 cc. capacity, and about 15 cc. of arsenic free concentrated sulfuric acid added. The flask was then placed over a medium flame and heated until fumes of sulfur dioxide were given off. Fuming nitric acid (arsenic free) was next added in small quantities (2 cc.) at short intervals until all the organic matter was oxidized and the solution was perfectly clear. The solution was then digested over a hot flame for two hours. Following the digestion the excess of sulfuric acid was carefully driven off and the arsenic determined by titration with fiftieth-normal iodine solution after reduction with potassium iodide, according to the modified Gooch and Browning method (Bul. 107 Revised, Bureau of Chemistry, U. S. Dept. of Agr., p. 239). The results were calculated in terms of milligrams of arsenic oxide, As_2O_5.

The data obtained from the analytical work are given in the following tables.

For convenience in making comparisons, the milligrams of arsenic oxide in 1 gram of dried tissue have been estimated in each instance.

EXPERIMENT No. 1

No.	Spray	No. of Caterpillars	Weight of Dry Tissue (Grams)	Milligrams of Arsenic Oxide (As_2O_5)	Milligrams of Arsenic Oxide (As_2O_5) to 1 gram of Dry Tissue.
1	2:50 L.H.A.	445	3.976	2.96	0.74
2	2:50 B.L.A.	205	1.423	0.86	0.60
3	2:100 L.H.A.	341	1.262	0.86	0.68
4	2:100 B.L.A.	202	1.623	0.48	0.30
5	2:200 L.H.A.	371	1.751	0.40	0.23
6	2:200 B.L.A.	220	1.056	Trace[1]	
7	2:400 L.H.A.	332	1.674	0.34	0.20
8	2:400 B.L.A.	201	.831	Trace	
9	2:800 L.H.A.	418	1.337	0.08	0.06
10	2:800 B.L.A.	291	2.035	0.28	0.14

[1] One drop fiftieth normal iodine for titration.

EXPERIMENT No. 2

No.	Spray	No. of Caterpillars	Weight of Dry Tissue (Grams)	Milligrams of Arsenic Oxide (As_2O_5)	Milligrams of Arsenic Oxide (As_2O_5) to 1 Gram of Dry Tissue.
1	2:50 L.H.A.	176	3.383	2.30	0.62
2	2:50 B.L.A.	261	3.520	1.72	0.49
3	2:100 L.H.A.	240	4.046	1.86	0.46
4	2:100 B.L.A.	191	3.150	1.50	0.47
5	2:200 L.H.A.	185	2.990	0.72	0.24
6	2:200 B.L.A.	453	4.835	1.29	0.26
7	2:400 L.H.A.	302	3.790	0.86	0.23
8	2:400 B.L.A.	284	3.222	0.57	0.18
9	2:800 L.H.A.	284	3.719	0.43	0.11
10	2:800 B.L.A.	152	2.303	0.15	0.06
11	2:1200 L.H.A.	280	3.582	0.28	0.08
12	2:1200 B.L.A.	223	2.354	0.15	0.06

These results show that in most cases the arsenic content of the caterpillars poisoned with the lead hydrogen arsenate was somewhat greater. This fact may be partly due to the higher arsenic content of this compound. It is also possible that this substance, being more chemically reactive, is more rapidly absorbed into the tissues while the inert basic compound passes through the intestinal tract of the insect without the absorption of so much of the arsenic.

In conclusion, we acknowledge our indebtedness to Mr. R. H. Robinson who assisted in making the chemical analyses here reported and to Mr. G. F. Moznette who assisted in the Entomological work.

VICE-PRESIDENT COOLEY: Mr. George P. Gray will present the next paper.

SULFUR AS AN INSECTICIDE

By George P. Gray

(*Withdrawn for publication elsewhere.*)

A large number of photographs illustrating the work of the Mediterranean fruit fly were exhibited by Mr. E. A. Back.

Session adjourned, 12 m.

Afternoon Session, August 10, 1915

The session was called to order at 2.15 p. m. by Mr. H. F. Wilson, president of the Pacific Slope Association of Economic Entomologists.

President Wilson: We will now listen to a paper prepared by Mr. C. P. Clausen which will be read by Mr. S. W. Foster.

A COMPARATIVE STUDY OF A SERIES OF APHID-FEEDING COCCINELLIDÆ[1]

By C. P. Clausen, *University of California Citrus Experiment Station, Riverside, California.*[1]

Among the beneficial insects of California as well as elsewhere, the Coccinellidæ hold high rank as aphid and scale feeders. In order to determine the relative efficiency of some of the more important forms, a study of eight of the principal aphid-feeding species of this state was made at Sacramento during the season of 1913, and completed at Berkeley and Riverside in 1914. The species under observation were: *Hippodamia convergens* Guer., *Hippodamia ambigua* Lec., *Coccinella californica* Mann., *Coccinella trifasciata* Linn., *Olla oculata* Fabr., *Olla abdominalis* Say., *Cycloneda sanguinea* Linn., and *Adalia bipunctata* Linn.

At the time the investigations were undertaken, an extensive series of tests were made to determine the most satisfactory type of breeding cage for use in the laboratory. By far the most satisfactory results were secured by confining the individuals under observation in plain three-inch vials with cotton stoppers. The stoppers were covered

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[1] Paper No. 19. Citrus Experiment Station, College of Agriculture, University of California, Riverside, Cal.

with tissue paper to prevent the larvæ from becoming enmeshed in the cottony fibers. Approximately outdoor conditions as regards temperature and humidity were thus secured. Potted plants infested with aphids and covered with chimney glasses were tried for a time, but did not fulfill the requirements, due to the occasional condensation of moisture upon the glass surface and the tendency of the adult beetles to ascend to the top of the glass and to remain there inactive rather than feeding normally upon the infested plant.

The points taken up in the investigation were the following: The length of time intervening between emergence and mating and oviposition, the length of the oviposition period, the rate of oviposition, both as to the number of eggs per day and the total number for the entire period, the life histories, and the feeding habits, both in the larval and adult stages. In every case a sufficient number of individuals were started for each species to make it practically certain that at least ten would complete the test, making allowance for unavoidable mortality. The records given for each species, therefore, represent the average for approximately that number of individuals.

Emergence to Mating and Oviposition

No great divergence was found to exist between species as regards the length of time intervening between emergence and mating. The range extended from 1.6 days in the case of *A. bipunctata* to 2.7 days for *C. californica.* No records were secured of *H. convergens* due to the fact that all individuals used in the tests were taken from cold storage in the adult stage. From mating to oviposition the variation was from 8.6 days for *O. abdominalis* to 11.9 days for *C. californica.* The minimum period of time for a single individual was 7.0 days in the case of one female of *O. abdominalis* and one of *C. sanguinea.*

The Period of Oviposition

The period of time over which oviposition extends is very largely dependent upon the conditions under which the beetles are kept. Under optimum conditions the deposition of eggs takes place daily during a period extending from approximately two weeks after emergence until death. The maximum average was found to be 48.1 days for *H. ambigua* and the minimum 28.2 days for *A. bipunctata.* The comparatively low average for *H. convergens* may be accounted for by the fact that three of the eleven individuals under observation died within two weeks of the beginning of the experiment. Oviposition by one female of *H. ambigua* extended over a period of fifty-nine days.

OVIPOSITION RECORDS

Species	No. of Specimens	Length of Period, Days	Per cent Days Eggs Deposited	Average for Period	Average eggs Per Day
C. californica Mann.	10	31.0	69.5	207	8.0
C. trifasciata Linn.	10	29.2	75.0	249	8.4
H. convergens Guer.	11	33.3	63.8	299	8.9
H. ambigua Lec.	8	48.1	61.4	312	7.3
O. abdominalis Say.	9	34.7	70.3	234	6.3
O. oculata Fabr.	9	35.4	89.3	347	9.8
A. bipunctata Linn.	10	28.2	69.4	190	6.7
C. sanguinea Linn.	10	28.8	73.6	201	7.0

RATE OF OVIPOSITION

A very considerable difference was found to exist in the number of eggs deposited by the various species. As would be expected from field observations, *H. convergens* deposited the greatest number of eggs, 609 being secured from a single female, while the average for all individuals was 299, but leaving out of account the three females which died prematurely, the average for the species was 358 eggs. *O. oculata* was a very close second with 347, while *A. bipunctata* was least with a production of 190 eggs. The maximum number of eggs deposited by a single female in one day was 43 in the case of *H. convergens*, while *O. oculata* was last with a maximum of 22 eggs. The latter species, however, ranked first with respect to the daily average for the entire period with 9.8, while *O. abdominalis* was last with 6.3 eggs per day.

FREQUENCY OF OVIPOSITION

The proportion of days upon which eggs were deposited varies greatly, the range being from 61.4 per cent for *H. ambigua* to 89.3 per cent for *O. oculata*. The latter species was found to be markedly uniform in this respect, the range among the nine individuals of the species being from 84.3 to 95.5 per cent, the minimum in this case being higher than the maximum of any other species. It will be noticed, however, that the regularity of oviposition was not in direct proportion to the total production of eggs, inasmuch as *H. ambigua*, the lowest with respect to the frequency of oviposition, ranked second in total production.

LIFE-HISTORY

A greater or less uniformity exists among the various species as regards the length of the different periods or stages of the life cycle. The egg stage ranged in length from 4.2 days for *O. abdominalis* to 6.0

days for *C. trifasciata.* In no case were more than six days required for incubation. Almost invariably the eggs comprising a cluster all hatched within a few hours. The first larval stage varied from 3.3 days for *O. abdominalis* to 5.7 days in the case of *C. californica.* A single larva of *C. californica* required ten days, but apparently was not normal and died shortly after pupation. The second larval stage was found to be uniformly shorter than the first, the variation being from 2.3 days for *O. abdominalis* to 4.7 days for *H. ambigua.* Nine larvæ of *H. ambigua*, three of *C. californica,* and one of *H. convergens* required only two days for this stage, while one specimen each of *H. ambigua* and *O. oculata* required six days. The third stage was of approximately the same length as the second, with the exception of *H. convergens,* in which case the period was much shorter. Two individuals of *O. oculata* required five days. The fourth stage was considerably longer than those preceding it, the range being from 4.7 days in the case of *O. abdominalis* to 7.4 days for *C. trifasciata.* The greatest variation, however, was found in the pupal stage, where 3.5 days were required by *O. abdominalis* and 8.0 for *H. ambigua.* The totals of the successive stages gave a minimum of 21.0 days for *O. abdominalis* and a maximum of 33.2 days for *H. ambigua.*

Duration of Different Stage in Days

Species	No. of Specimens	Egg Stage	Larval Stages.				Pupal Stage	Total
			First	Second	Third	Fourth		
C. californica Mann.	13	5.4	5.7	3.3	3.4	6.8	4.5	29.1
C. trifasciata Linn.	12	6.0	5.3	4.2	3.3	7.4	3.7	31.8
H. convergens Guer.	8	5.0	3.9	3.6	2.3	6.5	7.5	28.8
H. ambigua Lec.	10	5.5	3.8	4.7	3.6	7.3	8.0	33.2
O. abdominalis Say	14	4.2	3.3	2.3	2.8	4.7	3.5	21.0
O. oculata Fabr.	11	5.0	4.6	4.5	4.2	7.0	5.1	30.2
A. bipunctata Linn.	7	5.0	4.6	2.9	3.0	5.6	6.0	26.7
C. sanguinea Linn.	10	5.3	4.5	3.7	3.2	4.9	4.2	25.3

Feeding Records

The average number of aphids eaten by a larva during the entire period ranged from 216 for *C. sanguinea* to 475 in the case of *C. californica.* One individual of the former species came to maturity after consuming 147 aphids, while one larva of *C. californica* required 580, this being the maximum for a single individual.

Daily feeding records of the adult beetles covering a fifteen-day period were secured with the exception of *H. convergens,* the records of which extend over only eight days. The maximum period average

was 624 aphids for *O. oculata,* and 234 as a minimum for *C. sanguinea.* One adult of the former species devoured 672 aphids during this period. On a daily basis the variation extended from 56.1 aphids per individual for *H. convergens* to 15.6 for *C. sanguinea.* *C. californica* was conspicuously low in this respect when the size of the beetle is considered, the average being only 34.0 aphids per day.

FEEDING RECORDS

Species	Larvæ				Adults		
	No. of Specimens	Length of Stage	Aphids Eaten		No. of Specimens	Length of Period	Aphids Eaten per Day
			Period	Daily			
C. californica Mann.	13	23.7 da.	475	24.9	10	15 da.	34.0
C. trifasciata Linn.	13	25.8	294	15.8	10	15	28.9
H. convergens Guer.	12	23.8	349	20.7	6	8	56.1
H. ambigua Lec.	8	27.7	312	11.4	10	15	26.5
O. abdominalis Say	14	16.7	240	19.8	9	15	30.4
O. oculata Fabr.	10	25.2	326	17.2	10	15	41.6
A. bipunctata Linn.	10	21.7	252	14.1	10	15	16.7
C. sanguinea Linn.	10	20.0	216	14.5	10	15	15.6

On the basis of the results secured in the studies previously outlined, the following conclusions may be drawn:

1. Temperature and humidity are very strong controlling factors in the development and behavior of the different species.
2. The number of eggs deposited under normal field conditions varies from 200 to 500 and occasionally more, extending over a period of four to eight weeks in case the female lives the full adult life.
3. The period intervening between emergence and mating is one to three days, and from mating to oviposition eight to eleven days. A period of ten to fifteen days thus intervenes between emergence and the beginning of oviposition.
4. Oviposition normally takes place daily, with occasional exceptions.
5. The number of aphids eaten by the larvæ of the different species varies approximately with the size of the individuals, the number varying from 216 to 475 for the entire larval period.
6. The above to a somewhat lesser extent is true of the adults also.

PRESIDENT WILSON: The next paper is by Mr. J. F. Illingworth and will be read by Mr. O. H. Swezey.

NOTES ON THE HABITS AND CONTROL OF THE CHICKEN FLEA

(*Echidnophaga gallinacea* Westwood)

By J. F. Illingworth, Ph.D., *Professor of Entomology, College of Hawaii, Honolulu, T. H.*

In this paper the writer desires to briefly summarize data which is to appear later in a bulletin from the College. His investigation of the life-history of the chicken flea shows that there is a great similarity in the development with that of ordinary fleas; and, that it is only in their adult stage where they become markedly specialized. Reviewing the literature we find numerous short references to this species, but none that would indicate a thorough knowledge of the life-cycle and means of control.

The species has appeared under several generic names since Westwood (1875)[1] placed it in the genus *Sarcopysllus*. Enderlein (1903) created the genus *Argiopsylla* for it; and Baker, (1904) recognizing that it differed widely in structure from *Sarcopsylla penetrans*, gave it the new genus *Xestopsylla*. Finally, Jordan and Rothschild (1906) placed it in Olliff's (1886) old genus, *Echidnophaga*.

Hosts

Though, normally, fleas of this species infest poultry, the indication is that they attack any animal that comes in their way. The records mention dogs, cats, horses, rats, owls and man. They are particularly fond of young animals, and it has been noted that they are sometimes very annoying to children. In East Africa, 22.5 per cent of the fleas taken from rats were found to belong to this species; hence, these rodents are thought to be an important agent in their distribution. Recently, the writer discovered that they also infest the English sparrows, that flock into the chicken houses to the feed boxes.

Distribution

Though Westwood's description, in 1875, was from specimens found in India, the species is now pretty generally distributed around the world, favoring tropical and sub-tropical regions. A few of the places mentioned in the literature are: Africa, Italy, Russia, Asia, Fiji Islands, and America. This flea has been recorded in the southern United States since 1890; and one record extends the range as far north as Minnesota.

[1] See bibliography.

Life-History

In the study of the development of the fleas every effort was made to duplicate natural conditions. The fact that the adults of this species locate themselves rather permanently greatly simplified the problem of observing their habits of mating, egg-laying etc.

Newly emerged fleas, of both sexes, were placed in a large glass jar with a young rooster. The next morning ten females and eight males were found located upon the head of the bird. Short, gelatin capsules were then glued to the head, covering individual female fleas, so as to determine the number of eggs produced. During the day from one to two eggs were laid by each female, but on the following morning the capsules were full of eggs, and small pellets of blood—the excrement of the fleas. Careful observations were continued, renewing the capsules daily, as long as the fleas lived. It was a noticeable fact that egg-laying took place principally at night—often as many as forty eggs being produced by a single female at night and only one or two during the day.

Mating.—A careful, daily chart was kept of the location of the individual fleas on the rooster's head, and it was noted that the males shifted their positions during the night, but remained rather stationary during the day. The females remained practically in one location throughout their life—changing their position only when considerably disturbed, in some way.

Evidently, mating normally takes place at night, for rather constant daily observation failed to discover pairs in copula. On one occasion, some males that had emerged several days previously were placed on the bird, and after a short time they were observed copulating with the females which had been without males for several days. It is rather interesting to note, that in this species the male backs up to the female from below, extending and curving the end of his abdomen backward to secure the union, while he is practically standing on his head. The pairs observed remained attached only about five minutes.

Longevity Relative to Sex.—Of the fleas under observation on the fowl, the males quickly died off—living from two to six days after feeding and mating—while females lived from eighteen to forty days; producing eggs up to the time of their death.

In an experiment with fleas kept in jars without food or moisture after emerging, just the opposite was the case, the males greatly outliving the females—some of them remained alive and active for a full month.

Egg-Laying.—The fleas must evidently feed upon blood before they mate or are able to produce eggs. Several hundred newly

emerged fleas that were confined for many days in vials and jars without feeding, were not observed to mate and in no case were eggs produced.

Female fleas removed from fowls and placed in empty vials oviposit at once—from one to three eggs being produced. These fleas, if left in the vials, usually died during the following day.

Egg-production appears to depend largely upon the proximity of the males. The first and second day after mating the maximum number of eggs are produced; and, from that time on the number rapidly falls off until mating takes place again. Often females, that were not kept supplied with males, produced eggs which dried up quickly. By placing fresh males on the rooster's head from time to time, it was found that the females reproduced actively throughout their life.

The Eggs.—The eggs are laid singly, and, being dry, they rolled about in the capsules, so that it was rather difficult to keep them from falling out. They are oval in form, about one third longer than wide, and a beautiful opalescent white.

Since the eggs are largely produced at night, they may be found abundantly on the roosting-board of infested fowls.

The Larvæ.—The incubation period was found to vary from three and one-half to four days, at ordinary summer temperature. Eggs kept under observation during hatching became yellowish; and by transmitted light the larva could be plainly distinguished within. By a jerking motion of the body, the hatching spine, which is located on the top of the head of the larva, was observed effectively making a single slit in the egg-shell; through which the larva escaped.

The newly-hatched larvæ are quite white and very active, wriggling about over the surface of the soil. Within a few hours, if kept under natural conditions, they turn dark, due to the food within the alimentary canal. As was mentioned above, the parent fleas are constantly producing pellets of dried blood, which fall with the eggs to the soil. The larvæ apparently feed upon this excrement exclusively.

The larvæ were found to molt three times—the hatching-spine disappeared at the first molt. The older larvæ burrow into the soil so that they were always found at the bottom of the jars in the experiments. When ready to pupate the food all leaves the alimentary canal and the larvæ become pearly-white again. The larval period was found to vary considerably—lasting from six to ten days at summer temperature.

The Pupa.—When ready to pupate the larva spins a delicate cocoon, of the finest silk, which holds the particles of dust together around it. In most cases these cocoons were made against the glass, at the bottom of the breeding jars, so that the transformations could be observed through the wall.

After building the cocoon the larva remained doubled up inside for three to four days before pupating. The pupal stage lasts from six to nine days; the pupa beginning to turn dark several days before emerging. The entire life cycle, from egg to adult flea, was found to vary from twenty-two to twenty-nine days under ordinary summer conditions in Hawaii.

Control

Since the development in the early stages of this species follows so closely that of other fleas, standard methods of control were tried. The water treatment proved very successful. After washing out the roosting place each morning for a week, the fleas on the chickens became noticeably less; and after two weeks of such treatment they had practically disappeared.

Investigation shows that these fleas are most troublesome in dry localities and that wet districts, near the mountains are not troubled.

A Japanese, who has about two thousand fowls, located in the dry district, told the writer that he had no trouble with fleas, but that he did not know why he was free from them.

It was observed that he swept out the roosting places each morning; placed the droppings in water to macerate before applying them to his garden; and, that he used the sprinkling pot freely in the houses to keep down the dust. His treatment is one that recommends itself, not only for the general sanitation and health of the fowls, but also, it is a most satisfactory means of destroying the fleas.

Air-slacked lime has also proved very destructive to the developing fleas, and may often be used to advantage about the poultry house. A little of the dust-lime in the nests and other places, where it is better not to use water, keeps not only fleas but other pests from developing. In locations where water is scarce, the lime may be substituted, placing it under the roosts, etc.

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President Wilson: The next paper will be presented by Mr. A. F. Burgess.

SOME PHASES OF GIPSY MOTH WORK IN NEW ENGLAND

By A. F. Burgess, *Melrose Highlands, Mass*

(*Withdrawn for publication elsewhere.*)

President Wilson: We will now listen to a paper by Mr. E. D. Ball.

THE DISTRIBUTION OF THE BEET LEAF-HOPPER

By E. D. Ball, *Logan, Utah*

(*Withdrawn for publication elsewhere.*)

A general discussion followed this paper in regard to the leaf-hopper transmitting the disease concerned and it developed that definite facts concerning the transmission of the disease had been worked out under laboratory and field conditions by Prof. R. E. Smith and his associates in the University of California and would be published in a forthcoming number of *Phytopathology*.

President Wilson: The last paper on the program will be presented by Mr. G. N. Wolcott.

THE INFLUENCE OF RAINFALL AND THE NON-BURNING OF TRASH ON THE ABUNDANCE OF DIATRÆA SACCHARALIS[1]

By George N. Wolcott

(*Abstract*)

The most important insect injurious to sugar cane in the Western Hemisphere is the smaller moth stalk borer, *Diatræa saccharalis* Fabr., which occurs in abundance in the southern United States, Mexico, Cuba, Jamaica, Santo Domingo, Porto Rico, St. Kitts, Barbados, Trinidad, Demerara, and Argentina, besides other islands and countries of lesser importance in sugar production.

The larvæ of *Diatræa* cause the injury to the cane, as they bore into the stalks, eating the soft juicy pulp, opening the way for disease

[1] Published by permission of Mr. W. V. Tower, Director, Insular Experiment Station, Rio Piedras, Porto Rico.

organisms to enter, reducing the amount and purity of the juice, and weakening the strength of the stalk. The pupa is formed in the stalk, and the creamy-yellow, inconspicuously marked moths deposit eggs on the upper leaves of the cane.

The writer has visited most of the cane growing countries, and, being impressed by the notable variation in the amount of cane infested with the borer larvæ, has endeavored to determine the factors governing the abundance of the insect.

Working along similar lines in Louisiana, Mr. T. E. Holloway has contended (*Louisiana Planter*, December 19, 1914) that the abundance of *Diatræa* depends in large part upon the scarcity of the cosmopolitan and omnipresent egg parasite of the borer, *Trichogramma minutum*. Field experiments in Texas and Louisiana, carried on for two years by Mr. Holloway, have quite effectually demonstrated that the burning of the cane trash (tops and leaves) after the cane is harvested, destroys large numbers of *Trichogramma*, as is evidenced by a larger number of cane stalks injured by *Diatræa* in the succeeding crop than in check fields where the trash is not burned.

A large number of careful observations made in Porto Rico during the past grinding season, confirmed by the evidence from other countries, indicates that there is a constant relation between the amount of rainfall and the abundance of *Diatræa*. The accompanying table, which gives the percentages of infestation of cane by *Diatræa* in conjunction with the total annual rainfall in inches for 1914, shows that the abundance of *Diatræa* is in inverse proportion to the amount of rainfall. In the table, the abundance of *Diatræa* in fields where the trash was burned, and where the trash was *not* burned, is recorded separately, the difference amounting to nearly 100 per cent higher infestation by borer in fields where the trash has been burned.

That rainfall affects the abundance of the smaller moth borer is of scientific interest, but apparently no economic application can be made of this fact. But it is possible for planters to take advantage of the relation which has been found to exist between trash burning and borer infestation, and stop burning trash. In Cuba and northern Porto Rico, trash is seldom burned, and practically never in the British colonies. With a better understanding of the losses attendant upon burning the trash, it can usually be obviated elsewhere by the use of improved heavy-ratooning varieties and somewhat altered plantation practice.

It is comparatively easy to demonstrate the effect of an abundance of rainfall in lessening the numbers of *Diatræa*, but much more difficult to satisfactorily account for this effect. The eggs of the borer are deposited on the leaves of the cane, and when the young larvæ hatch, a considerable interval elapses while they crawl about on the cane

before they enter the stalk, or the midrib of the leaf. It is quite probable that this is one of the most crucial periods in its life history and that many newly hatched larvæ fail to enter the cane before they are washed off by the rain. It was observed in Cuba that considerable numbers of borer larvæ were killed in young cane by the more rapid growth of the central shoot of a cane plant than of the outer leaves. Also, larvæ were found which had been drowned in a mixture of water and decaying cane juices which had collected in their tunnels after rains. To avoid danger from these causes, many larvæ were found living outside the shoot, where they were exposed to the attacks of predators or parasites.

Summary

The abundance of the smaller moth borer, *Diatrœa saccharalis*, the most important pest of sugar cane in the New World, depends upon two factors, rainfall and the burning of trash. Rainfall cannot be controlled, but in many cases in Porto Rico and elsewhere trash is needlessly burned. Burning trash increases the abundance of the borer 100 per cent. It is desirable that the burning of trash be avoided.

Total Annual Rainfall and Average Infestation of Sugar-Cane by Diatræa saccharalis at Various Localities in Porto Rico, also Infestation in Fields where the Trash Was Burned and where the Trash Was Not Burned.

Locality	Inches of Rainfall, 1914	Percentage of Infestation, 1914–15		
		Average of all Fields	Fields where Trash Was Burned	Fields where Trash Was *not* Burned
Coloso	101	6 (8)		6 (8)
Anasco	95	5 (6)		5 (6)
Fajardo	76[1]	11 (15)	13 (6)	9 (9)
Manati-Morovis	72	6 (9)	10 (2)	4 (7)
Canovanas	70	11 (4)		11 (4)
Toa Baja	70	15 (8)	19 (4)	10 (4)
Rio Piedras	66	17 (7)		17 (7)
Vega Baja	66	39 (9)	44 (5)	26 (4)
Caguas	58	6 (5)		6 (5)
Yabucoa	58	37 (5)	60 (2)	22 (3)
Arecibo	55	26 (16)	69 (1)	23 (15)
Juana Dias	60	32 (9)	34 (8)	18 (1)
Guayama-Josepha	45	47 (4)	47 (4)	
Aguirre	34	45 (7)	50 (5)	31 (2)
Potala	27	37 (9)	44 (6)	24 (3)
Ponce	25	48 (8)	48 (8)	
Destino-Salinas	23	64 (5)	77 (3)	44 (2)
Guayanilla	24	76 (5)	76 (5)	
Sn. Isabel	22	72 (4)	78 (3)	46 (1)
Guanica	21	66 (28)	68 (24)	31 (4)

Note.—Figures in ( ) after percentages indicate numbers of fields examined.

[1] Average of rainfall of haciendas, not of the town.

Mr. O. H. Swezey: Trichogramma has a short life cycle and in case the trash could be left a short time the adults would emerge.

Mr. G. N. Wolcott: In Porto Rico the cane and trash is burned immediately.

Vice-President Cooley resumed the chair and called for the report of the committee on resolutions.

REPORT OF COMMITTEE ON RESOLUTIONS

Resolved, That the American Association of Economic Entomologists at its special summer meeting desires to voice its appreciation, first, to the authorities of the University of California, for courtesies extended; second, to the Pacific Slope Association of Economic Entomologists and to the individual entomologists for their coöperation; and, lastly, to Professor R. A. Cooley, for his able supervision at the sessions and for his timely address.

E. A. Back,
F. C. Bishopp,
A. L. Melander,
Committee.

By vote of the association the resolutions were adopted.

Vice-President Cooley: We will now listen to the report of the committee appointed to confer with a similar committee from the Pacific Slope Association of Economic Entomologists.

REPORT OF SPECIAL COMMITTEE[1]

Your committee, appointed to confer with a like committee from the Pacific Slope Association of Economic Entomologists with reference to an affiliation, recommend that that Association be affiliated as a branch association to be known as the Pacific Slope Branch of the American Association of Economic Entomologists and that the membership requirements, dues and privileges of its members be the same as for other members of this Association.

It is further recommended that the following amendment to the constitution providing for this change be adopted.

That the words "Branch or" be inserted before the word "section" in line 2 of Section 1 of Article 3 of the Constitution.

Respectfully submitted,

C. P. Gillette,
A. F. Burgess,
E. D. Ball,
E. O. Essig,
Committee.

After a general discussion it was voted that the report be accepted and that the recommendations be presented to the American Association of Economic Entomologists at the next annual meeting.

[1]As the members of the committee agreed on the matters under consideration, a joint report was submitted.

Before adjourning, the Secretary called attention to the fact that the meeting had been favored with the presence of three past presidents of the Association and that this had added much to the occasion, also that it was an especial pleasure that Prof. Lawrence Bruner, who had recently been honored by his state as its most distinguished citizen, was present on this occasion.

There being no further business the session adjourned at 5 p. m.

R. A. Cooley, *Vice-President.*

A. F. Burgess, *Secretary.*

GRYLLOTALPA GRYLLOTALPA LINN., THE EUROPEAN MOLE CRICKET IN NEW JERSEY

By Harry B. Weiss, *New Brunswick, N. J.*

During the early part of July, 1915, my attention was called to an underground insect which was cutting off the roots of various plants in a nursery at Rutherford, N. J. Upon making a search, a mole cricket considerably larger than our common but by no means abundant *Gryllotalpa borealis* Burm., was found to be responsible for the injury. Mr. J. A. G. Rehn, to whom a specimen was submitted, pronounced it *Gryllotalpa gryllotalpa* Linn., the European mole cricket. The infestation which is undoubtedly of several years' duration, extends over several acres planted to herbaceous and ornamental stock, a considerable portion of which is used for show purposes only. The soil is rather light and porous and contains a variety of shrubs, shade trees, evergreens, etc., such as one would naturally find in a nursery. No preference was shown by the cricket for any particular plant, its zig-zag burrows being found in different parts of the area irrespective of the kinds of plants growing there.

The insects were numerous enough for the nursery to detail several men to hunt them out and destroy as many as possible every few days and to sink empty flower pots in the ground, covering them with boards, for trapping purposes.

Malcolm Burr in his "Synopsis of the Orthoptera of Western Europe" records this species as occurring through Europe, and from Sweden to Spain, rare and local in England, abundant in France, often doing damage to gardens, common in Belgium. At Rutherford, where the insect was discovered, large amounts of imported stock are received every year. There were consigned to this locality during 1914, more than five thousand parcels of imported stock and during the spring of 1915, over two thousand parcels were received. The majority of this stock comes from Belgium and Holland and only a small

portion from France. Inasmuch as it is chiefly Holland and Belgian stock which comes over with soil around the roots and inasmuch as a porton of this is always planted temporarily in the now infested area, it is almost certain that the insect came from one or both of these countries.

E. Bourcart in "Insecticides, Fungicides and Weedkillers" gives a short account of this species in which he states that it lives almost entirely on insects and their larvæ, cutting all roots that hinder it in its search for this food. The winter is passed at various depths, depending upon the temperature and amount of moisture present. In the spring it ascends and excavates numerous runs within a few centimetres of the surface. Bourcart further states that it takes twelve years for the number of these insects to increase so far as to render culture impossible. The existence of each insect is three years, each female depositing two hundred eggs, but multiplication is comparatively slow.

Other European writers state that the food of the mole cricket consists largely of vegetable matter but all agree in that it is cannibalistic at times. According to Bastin, eggs are laid in a specially constructed chamber, the adult caring for them and feeding the young until their first moult, when the family disperses.

Coming to remedies, Bourcart mentions the use of poisoned pastes, of maize, starch, water and phosphorus, being placed in the burrows and the openings closed. In Italy, liming at the rate of 16 cwt. to the acre is supposed to remove the crickets. Petroleum or a 25 per cent emulsion of petroleum poured into the burrows has also been used in Europe. Ratzeburg, in 1847, advised the injection of oil into the tunnels and afterward sprinkling the surface with water. Bourcart also mentions the use of naphthaline in the ground as it is being tilled and also raking the soil until the surface is clean, then beating it and adding water if necessary. During the night the mole crickets dig new tunnels which are seen the next morning. These are opened with the fingers and tepid soapy water poured in.

Worsham and Reed, in Bull. 101 of the Georgia Experiment Station on *Scapteriscus didactylus* Latr., advocate for that species the ploughing of breeding areas to destroy the eggs by exposing them to the sun, etc., light traps at certain seasons, compost heap traps during the winter, poisoned baits made of cottonseed meal and arsenicals, sulphur and naphthaline as repellants and the banding of individual plants by means of tin, paper or wire cylinders.

The presence of the European mole cricket in New Jersey is simply an example of how impossible it is to keep out all foreign pests by a close inspection of foreign stock. No matter how careful the inspector is, something is bound to get by and cause trouble later on.

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The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engraving, may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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The California meeting shows that the term American has a vital meaning in the name of the Association and the action of the Pacific Slope Association of Economic Entomologists indicates a willingness on the part of the members of that organization to make the adjective under discussion thoroughly characteristic. It is by all means better to have one strong association providing adequate representation and opportunity for the varied interests and it is hoped that the preliminary action of last summer may come to a successful fruition at the next annual meeting. Many problems are being studied under varying conditions found in different parts of the country and it is most desirable that the strongest association of practical entomologists should be comprehensively American in its membership, and recognize, as it does in its foreign members, the great value of the work done in other countries.

The report of the special summer meeting indicates an interesting and profitable gathering. It is regrettable that not more of the eastern men could attend and secure for themselves every benefit to be derived from national sessions held in regions presenting not only peculiar but important entomological problems. There is much for the eastern man to learn from his colleagues of the West. California has led the way with county entomologists. It was within her boundaries that the utility of hydrocyanic acid gas for the fumigation of fruit trees was demonstrated, that the lime, salt and sulphur wash (primarily a sheep dip) was first applied to fruit trees and there also occurred a most striking demonstration of how insects may be used to control insects and the necessity of one insect to the production of an important fruit. These bright pages of entomological history

were written under the stimulus of specialization compelled by climatic and other conditions. It is not too much to suppose that the excellent work of earlier years has been continued and in due time will result in additional contributions of both scientific and practical value. The pages may not all be as optimistic as those alluded to above, nevertheless they may contain much of great importance and contribute materially to the welfare of the nation. There are many specialities in the far West, controlled by men of keen intellect, and he who fails to keep an eye on his brother of the Pacific Slope should not complain if he falls behind in the race.

Obituary

JOSEPH TARRIGAN MONELL

Joseph Tarrigan Monell, prominent aphidologist and mining engineer, died at his home in St. Louis, Mo., May 9, 1915. He was born in St. Louis September 15, 1859, was educated at Smith's Academy and Washington University, from which latter institution he received the degree of mining engineer in 1881. Although his vocation was that of mining engineer, a profession which he practiced successfully, he was from the age of fourteen an ardent student of nature, more especially entomology and botany and was a volunteer student under Dr. C. V. Riley and under Dr. George Engelmann, the botanist. He was known among entomologists as an authority on the Aphididæ, in which group he published several articles, his first contribution being published at the age of seventeen. Although he published nothing after becoming actively engaged in engineering work, he continued his studies and was ever ready and willing to assist others. In his death entomology has sustained an irreparable loss. A widow and three children survive.

J. J. D.

Current Notes

Conducted by the Associate Editor

Instruction in beekeeping is soon to be given in the College of Agriculture of Cornell University.

Mr. A. H. Jennings, Bureau of Entomology, will be stationed in New York City, for some time, on mosquito work.

Dr. W. E. Britton, state entomologist of Connecticut, gave an illustrated lecture at the New York Botanical Garden, August 14, on "Fighting the Gipsy Moth."

Dr. A. A. Allen has been appointed assistant professor of ornithology in Cornell University and will give new courses in the economic phases of the subject.

Mr. Eric S. Cogan of British South Africa is employed as a temporary assistant, Bureau of Entomology, and has been assigned to the Charleston (Mo.) laboratory.

Mr. C. L. Scott of the Brownsville (Tex.) laboratory, Bureau of Entomology, is investigating the spread of the fall army worm (*Laphygma frugiperda*) in Texas and Louisiana.

Prof. F. L. Washburn, state entomologist of Minnesota, gave an address on "Problems in Nursery Inspection," before the American Association of Nurserymen at Detroit, June 23–25.

Dr. W. D. Hunter visited Boston, Albany, and other points in the northeast, in connection with the work of the Horticultural Board, during the early part of July.

Dr. Carlos J. Finley of Cuba, who thirty-four years ago claimed that mosquitoes were responsible for the transmission of yellow fever, died August 20, at eighty-two years of age.

Dr. W. C. Gorgas, surgeon general, United States Army, was scheduled as one of the speakers before the American Public Health Association at Rochester, N. Y., September 7.

According to *Science*, Dr. David Starr Jordan has recently been elected a member of the Royal Swedish Academy of Sciences at Stockholm, in appreciation of his work in zoölogy.

The Dominion of Canada has appropriated $20,000 for entomology, and $100,000 for the administration and enforcement of the destructive insect and pest act for the fiscal year of 1915–16.

Dr. T. J. Headlee, state entomologist of New Jersey, and Mr. B. H. Walden, assistant entomologist of Connecticut, were speakers at an anti-mosquito meeting at Sachem's Head, Guilford, Conn., August 14.

At a recent meeting of the directors of the Florida Citrus Exchange resolutions were adopted heartily indorsing the work against citrous pests, conducted by Mr. W. W. Yothers of the Bureau of Entomology.

Mr. Reuben Cox of the Mississippi Agricultural College has been appointed a temporary field assistant of the Bureau of Entomology and will work with Mr. D. L. Van Dine on the investigation of malaria mosquitoes.

About thirty members of the Baltimore Beekeepers' Club visited the apiary and aboratory of the Bureau of Entomology at Drummond, Md., on Saturday afternoon, July 24. Various demonstrations were arranged for them in the apiary.

According to *Science*, Mr. Charles P. Lounsbury, chief entomologist of the South African Union, who has been visiting Australia, was expected to reach San Francisco about September 1, and to spend several months in the United States.

Dr. A. L. Quaintance, Bureau of Entomology, recently visited field laboratories at Winchester, Va., North East, Pa., and Benton Harbor, Mich., for the purpose of conferring with men in charge of stations regarding work under way and contemplated.

Mr. V. G. Stevens of Leland Stanford Junior University, Cal., has been appointed as a field assistant in the Bureau of Entomology for the purpose of assisting Mr. W. M. Davidson at Walnut Creek, Cal., in investigations of the grape Phylloxera.

Mr. F. C. Craighead, Bureau of Entomology, recently spent about a week in Tyrone, Pa., in the study of insects affecting a plantation of poplar trees and the making of general observations on insects affecting forest and shade trees.

It has been announced in *Science* that the medal and grant for 1915 of the South African Association for the advancement of Science have been awarded to Mr. C. P. Lounsbury, chief of the Division of Entomology, Union Department of Agriculture.

Mr. W. D. Pierce, Bureau of Entomology, spent the latter half of July in determining the status of the boll weevil in the region first invaded during the fall of 1914, and in visiting the laboratories at Clarksville, New Orleans, Thomasville, and Batesburg.

Mr. G. N. Wolcott of the Porto Rico Board of Agriculture was in Washington on July 27. He will attend the meetings at San Francisco and in the fall will spend some little time as a collaborator at the laboratory investigating sugar-cane insects at New Orleans.

In the August issue of this Journal occurs a note copied from *Science* regarding the death of Joseph Farrigan. The name is an error and the note refers to the death of Joseph Tarrigan Monell. More information is given in the obituary notice on another page of this issue.

Mr. Dwight Isely, Bureau of Entomology, working on grape insects at North East, Pa., is visiting the Benton Harbor (Mich.) laboratory for the purpose of making observations on the grape-berry moth in that region. Upon completion of his investigation he will return to his headquarters at North East, Pa.

The American Medicine Gold Medal has been awarded to Surgeon General Rupert Blue of the Public Health Service, as the American physician who has done most for humanity in the domain of medicine during 1914. Dr. Blue was placed in charge of eradicating the bubonic plague from San Francisco in 1907.

The squash lady bird (*Epilachna borealis* Fab.) was reported as being very injurious during the last week of July to squashes in and near tidewater Virginia, where it has also been rated a pest of great importance in certain years. It will be interesting to know if this species causes such injury elsewhere.

According to *Science*, Edgar M. Ledyard, formerly assistant professor of entomology in the University of the Philippines, who has spent the last year in research work in the laboratory of parasitology of the University of California, has been appointed director of the Agricultural Department of the United States Smelting Company, Salt Lake City, Utah.

A circuit of beekeepers' meetings is to be held in the Middle West in December, ten associations meeting in succession. The object of this plan is to enable speakers and exhibitors to attend with the minimum expense and time. Meetings will be held in Ohio, Indiana, Illinois (2), Missouri, Kansas, Iowa, Minnesota, Wisconsin, and Michigan.

An outbreak of unusual severity of the onion thrips was reported to the Bureau of Entomology in Marshall County, Indiana, and vicinity, during July. The localities from which these reports emanated included Donaldson, Grovetown, Hamlet, Walkerton, and Plymouth, and our correspondents stated that the thrips seriously threatened the onion crop over a very considerable acreage.

Dr. A. H. McCray, Bureau of Entomology, is now stationed at the Drummond laboratory. He is continuing the work of examining samples of diseased brood sent in for determination, and is also taking up some new lines of investigation of bee diseases. Dr. McCray received the degree of doctor of medicine from George Washington University in June.

Prof. Wilmon Newell has resigned his position as state entomologist of Texas and professor of entomology at the Texas A. & M. College, to accept the position of state plant commissioner of Florida. As commissioner he will have charge of the work of citrus canker eradication and general supervision of the state work in entomology, plant pathology and nursery inspection, with headquarters at Gainesville.

The Colorado potato beetle, as has previously been announced, has been discovered at work on the Pacific Coast in the state of Washington. It has also been known to occur in Idaho for some time and it is invading new territory in Arizona and probably New Mexico. Agents and correspondents are urgently requested to report the occurrence of this species in any suspected new locality.

Mr. R. I. Smith, formerly of the North Carolina Experiment Station, but recently located in Porto Rico, has been appointed a quarantine inspector by the Federal Horticultural Board. He assumed his duties on August 16 and is stationed at Boston to have supervision over the imports of foreign cotton, and the erection of the fumigating plant which will probably be established at that place by the 1st of January.

Prof. Lawrence Bruner, state entomologist of Nebraska, professor and head of the Department of Entomology in the University of Nebraska, was selected by a committee, as Nebraska's most distinguished citizen, to attend the Panama-Pacific Exposition as guest of honor on August 19. At a luncheon given in his honor Professor Bruner was the recipient of a medal, presented by the exposition, bearing the inscription, "Professor Lawrence Bruner, Distinguished Citizen of Nebraska."

Aphides and flea-beetles have been very destructive in the vicinity of the District of Columbia, Maryland, and Virginia, but owing to adverse weather conditions, especially droughts followed by rain storms, experiments employed to test remedies have been unsatisfactory. Aphides of many species apparently entirely disappeared toward the end of July but some have reappeared in slight numbers. Ladybirds have been extremely active as checks; so much so that there appears to be no food left for them.

Although the Lyctus powder-post beetles, and especially their work, are well known, their biology, and particularly their method and place of oviposition, have remained obscure. During the past month Mr. T. E. Snyder, Bureau of Entomology, has concentrated his efforts on securing this information. After considerable painstaking work his efforts were crowned with success. He observed the beetles in the act of oviposition and located the eggs, which he found of unusual type for Coleoptera. He is now working out a full seasonal history of the insect.

In the Bureau of Entomology Dr. Hopkins' long official title of "entomological assistant in charge of forest insect investigations" has been changed to the more appropriate title of "forest entomologist." Likewise the titles of H. E. Burke, J. M.

Miller, Josef Brunner, W. D. Edmonston, T. E. Snyder, F. C. Craighead, and A. B. Champlain are now changed to read assistant in forest entomology. Similarly, the official titles of S. A. Rohwer, W. S. Fisher, Carl Heinrich, C. T. Greene, and A. G. Böving were changed to specialist on forest Hymenoptera, forest Coleoptera, forest Lepidoptera, forest Diptera, and coleopterous larvæ, respectively.

Excellent success has been reported from the use of the poisoned bran bait against grasshoppers from the West Springfield (Mass.) laboratory, Bureau of Entomology, where large areas along the Merrimac and Connecticut Rivers have been cleared of grasshoppers, 95 per cent having been killed at an expense of from 7 to 10 cents per acre. Equally good results have been secured in California by Mr. Urbahns, of the Pasadena laboratory, and also equally satisfactory results have been obtained at Fellsmere, Fla., by Mr. R. N. Wilson of the Gainesville (Fla.) laboratory. These three separate results were obtained from work carried out against entirely different species.

There has been a severe outbreak of the three-lined blister beetle (*Epicauta lemniscata* Fab.) in Louisiana. It has attacked principally potato and tomato. The first record of its occurrence was on May 17, when the beetles were reported stripping plants in parts of fields of Irish potatoes. On tomatoes they work in the same manner, doing much damage to young plants. At Jeffris, they were reported May 21 to be doing great injury. A correspondent wrote that they destroyed acres of potato vines and that no crop resulted and that they were seriously handicapped, since unless the insects could be controlled it would be useless to plant Irish potatoes in that vicinity. Mr. Thomas H. Jones, Bureau of Entomology, reported that the favorite food plant was the spiny amaranth (*Amaranthus spinosus*), and where this weed was growing between the cotton rows it was attacked to a small extent.

The entomological collection of the Bureau of Science at Manila has been transferred to the University of the Philippines, and is now located in ample quarters at the College of Agriculture, Los Banõs, Laguna, P. I., 65 kilometers from Manila by railroad. This collection, which contains most of the types of Philippine insects, described by European and American specialists during the past twelve or thirteen years, and containing, at present, more than 300,000 pinned specimens, together with alcoholic and biological material, will be materially increased in value by the collecting of faculty and students in the exceedingly rich faunal regions of Los Banõs, Mt. Maquiling and Mt. Banahao. Mr. Charles S. Banks, associate professor of entomology and chief of the department, writes that entomologists visiting the Philippines will be cordially welcomed to the laboratories and every facility for comfort will be placed at their disposal.

Scientific Note

The Corn-silk Beetle, *Luperodes varicornis* Lec., **and its Control.** About July 1, 1915, the small Chrysomelid beetle, *Luperodes varicornis*, appeared in enormous numbers in many corn fields of several counties in Mississippi. One correspondent wrote: "They attack the corn, completely eat the silk entirely back to the grain. Several hundred may be picked from one ear of corn." Another correspondent sent in a bottle containing ninety-four beetles which he said had all been taken from the silk of one ear. R. L. Saxon of Franklin County, Mississippi, estimates that one third of the corn crop in that vicinity had been lost because of the work of the beetle. The silk is eaten just as it grows out from the ear and

while it is fresh and succulent. The ears of the injured corn have the appearance of having had the silk cut off as by a knife, the feeding is so even and smooth. The beetle caused serious losses on many farms.

As the Luperodes beetles congregated only on the silk at the ends of the ears, and as the plants were in most cases at least eight to ten feet high with the ears five or six feet from the ground, difficulty was at first encountered in properly applying arsenical poisons. D. L. Williams of Rankin County, Mississippi, deserves credit for devising a very satisfactory method of applying the arsenicals for these beetles. He filled an ordinary "talcum powder" can with Paris green and while walking between the rows of corn stopped at each plant just long enough to shake the poison directly upon the silk. In this way none of the Paris green was wasted and it fell just where it was needed. The corn was treated rapidly as one man covered a number of acres each day. Mr. Williams stated that the men applying the Paris green walked at a slow steady gait. It required just one shake of the "talcum powder" can at each plant. In the fields that were treated in this manner, relief from these beetles was immediately obtained. Untreated fields were much more seriously damaged, as the beetles remained on the plants and continued to eat the silk as fast as it grew out from the ears.

All of the records we have of this species show that the beetles appear in injurious numbers about July 1 in the Gulf States. Some years no complaints are received and it is frequently a minor pest of cotton, devouring both the leaves and blossoms. In 1905 in his Monograph of Insect Injurious to Indian Corn, Professor S. A. Forbes wrote in regard to this beetle that "Its life-history is unknown." If anyone has learned anything in regard to the life-history of this species, it should be published.

R. W. Harned, *Agricultural College, Miss.*

TWENTY-EIGHTH ANNUAL MEETING AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

The twenty-eighth annual meeting of the American Association of Economic Entomologists will be held at Columbus, O., during the Christmas holidays. Members will be duly notified of further details concerning the meeting and of arrangements for hotel headquarters and railroad rates.

At the annual meeting action will be taken on applications for membership in the Association and blank forms for making application for membership can be secured from the Secretary or from Prof. Wilmon Newell, Gainesville, Fla., who is Chairman of the Committee on Membership. It is particularly requested that parties desiring membership should file their applications, properly made out, as early as possible so as to facilitate the work of the Committee on Membership at the time of the meeting.

A. F. Burgess, *Secretary.*

Mailed October 15, 1915.

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THEORY OF TOXICITY

By C. W. Woodworth

The most important work to be done in Economic Entomology is to lay a foundation of sound theories. The necessity of such work is well shown in the progress of fumigation where, for instance, the original publication [1] contained tables of dosage calculated on the assumption that the dose should be determined in proportion to the volume, and this erroneous theory still influences the thoughts of entomologists, though discarded from the first in actual practice. Again, when a careful study of the actual doses used for different sizes was made,[2] showing that the area of the tent corresponded much more closely than volume to the practice of fumigators, there was a universal adoption of this basis of calculation upon the erroneous theory that such a table correctly compensated for leakage. The only way a correct compensation can be secured is to measure the amount of leakage, which is now a very simple matter,[3] and then to use tables calculated for the various degrees of leakage.[4]

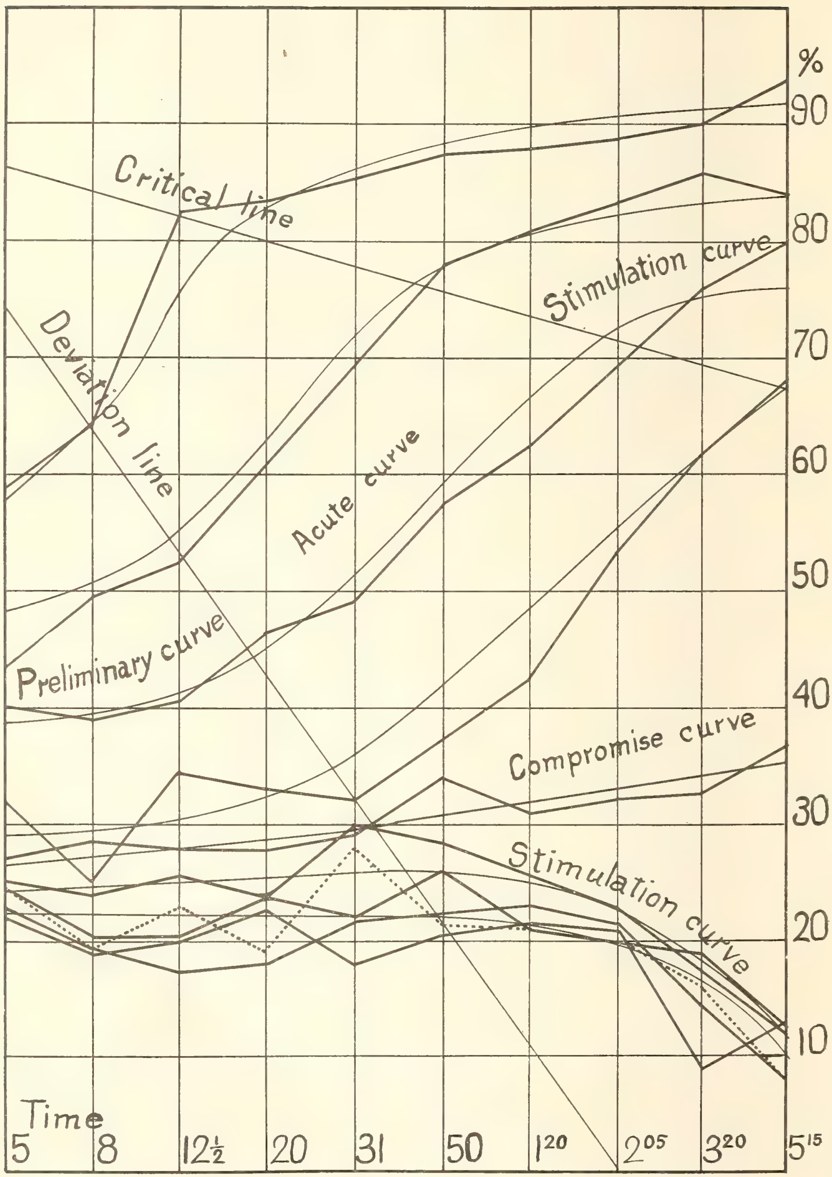
Each step in this progress was accomplished by efforts directed towards correcting the theory, and required the accumulation of a very large volume of data, since there are so many unknown variables that individual experiments are entirely unreliable. Many thousands of determinations were made in the study of leakage referred to above, and a series of 40,000 lots of scale insect eggs were used in obtaining the data discussed below. This quantity was not great enough to eliminate all the irregularities in curves shown in plate 28, but is without doubt the largest volume of laboratory data ever secured

[1] Bulletin 71, California Agricultural Experiment Station.

[2] Bulletin 152, California Agricultural Experiment Station.

[3] Circular 75, California Agricultural Experiment Station.

[4] Journ. Econ. Ent., Vol. iv, pp. 376–380. Bull. 220 and 257, California Agricultural Experiment Station.



Toxic phases

in any similar investigation and gives results of a very dependable character. The methods of study have already been described elsewhere,[1] and it will only be necessary to explain that this study presents the result of 200 sets of experiments, each set consisting of simultaneous determinations for each of the 100 points on the diagram, made with special care to insure that all the data in each set shall be comparable.

Each curve represents the percentages of the lots which failed to hatch after treatment in a certain density of gas through exposure for varying intervals of time. These intervals range from five minutes to five and one quarter hours. The intervals indicated by the vertical lines are in geometric progression. The horizontal lines represent the number of lots giving no hatch.

The strength of dose doubles towards the upper end of the table for each line, the topmost line being 512 times as strong as the weakest, which is dotted on account of its somewhat erratic position.

Seven theoretical curves are drawn which correspond very closely with the experimental data and show that very complex relationships exist. It is likely that the same facts will be found true for other insecticides and that we can establish, at least as a working hypothesis, the series of toxic phases shown on the diagram, with the definite relationships there indicated. These phases are as follows:

THE PRELIMINARY CURVE in which the toxicity is directly proportional to an increasing geometric series of time intervals, and for the stronger doses, is also directly proportional to an increasing geometric series of concentration intervals.

THE DEVIATION LINE is the center of a very evident zone where the toxic curves diverge. It seems to be inversely proportional to the toxicity during the preliminary period; that is, the less the killing the longer the interval, the increase of time corresponding with a decrease of dose being in geometric ratio and, therefore, making a straight line where the time intervals are plotted as in this chart.

THE ACUTE CURVE represents a different physiological action of the cyanid, possibly directly upon the nerve centers. It is a more abrupt and much longer continued action in the lower concentrations of the poison, resulting in a far greater difference in the time required to complete the action than in percent that finally dies. The proportional rate of killing during this acute phase is identical for all concentrations, the greater killing for low concentrations depending solely upon the longer time of action.

[1] Science, Vol. xli, pp. 267–269, and Report California Agricultural Experiment Station for 1914, pp. 114–116.

THE COMPROMISE CURVE is well shown in the fifth curve. Here the direction of the curve seems to be the result of two forces and might easily occupy any one of a great range of positions according to the relative power of the two influences. As shown in the diagram it is very closely half way between the Acute curve above and the Stimulation curve below.

THE STIMULATION CURVE represents a benign effect of cyanid. The fact that there is such an action in the case of this chemical has already been pointed out.[1] These curves show, in this case, that more than half of the lots of eggs that would have failed to hatch under normal circumstances have been made to hatch by the long continued action of the cyanid. The beginning of this stimulative effect has the same relation to the deviation line that the Acute curves show, and the rate of stimulation is similar but in an opposite direction, suggesting that the same causes are responsible in both cases. There must be profound physiological changes which are essentially beneficent but violently poisonous when carried to excess.

THE CRITICAL LINE represents a second evidently significant physiological crisis, bearing the same quantitative relationships with the concentration of the gas as the deviation line but with a greater time factor, though qualitatively indentical. It measures the culmination of the violent action of the poison and the beginning of the recovery. Those not dead at this time have a fair chance of survival. Perhaps the production of antibodies provides for the reduction of the quantity of poison within the body.

The method of plotting the results of experiments of this kind should be such that the irregularities at the two ends of the curves should be approximately of equal magnitudes, for in this way one will give proper weight to all the data.

This was done in the present case, the time intervals being arranged logarithmically. The fact that by this arrangement the deviation and critical lines are straight indicates that in general the phenomenon occurs in proportional rather than in consecutive intervals.

The theory of toxicity which this study enables us to put forward is (1) that there are three separate effects produced by a poison depending on its concentration; (2) that there is a line of deviation beyond which their characteristics become most evident; (3) that acute poisoning reaches a crisis after which the rate of death rapidly declines, and (4) that these phenomena exhibit a series of very definite mathematical relationships.

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[1] Science, Vol. xli, pp. 267–269.

A NEW MIXTURE FOR CONTROLLING WOOD-BORING INSECTS—SODIUM ARSENATE-KEROSENE EMULSION

By F. C. Craighead, *Branch of Forest Insects, Bureau of Entomology, United States Department of Agriculture*

During the past summer different substances were tried in an effort to kill wood-boring insects, such as *Goes* (work similiar to *Prionoxystus*) and *Cyllene pictus*. In view of the discovery by Dr. A. D. Hopkins that kerosene was effective on the locust borer (*Cyllene robiniæ*), this substance, kerosene emulsion, and carbolineum, were tried but proved of little value in these cases. The kerosene emulsion penetrated the wood and galleries but seldom was in quantity enough to kill the larvæ.

The idea occurred to poison the emulsion so that as it penetrated to the insects and they attempted to bore further, the poisoned wood would kill them. A soluble arsenate, sodium arsenate, was tried mixed with the water to be used in making the emulsion. A 5 to 10 per cent arsenical solution was used but it is probable that a much weaker strength will answer. The results were highly successful in all trials.

The same penetrative properties of the kerosene are retained, quickly soaking in several inches in seasoned wood and in living and seasoned wood through the frass in the larval mines often to a distance of ten to twelve inches.

Tests made on *Goes* mines in living trees showed that by painting the holes where the boring dust is exuded this solution quickly ascends along the sides of the burrow and through the frass, killing the larvæ in a few days. Hickory logs heavily infested with *Cyllene pictus* were washed with this solution, sponging it on the bark with a piece of cotton. In four days' time all the larvæ were killed and many had turned black. Mr. T. E. Snyder tested it on powder post beetles in seasoned hickory and oak. A week to ten days after one application all the larvæ were killed. Many were one and one-half to two inches in the wood.

As a preventative for wood borers, in construction timber, it has not been tested, but will no doubt give good results where the lumber is not exposed to severe weather conditions. Should the kerosene evaporate, the arsenic would remain deep in the wood unless leached out by contact with water.

NOTES ON ICHNEUMON LÆTUS BRULLÉ [1]

By Harry H. Knight

While breeding parasites from the army-worm (*Leucania unipuncta* Haworth) during the summer of 1914, males of *Ichneumon lœtus* Brullé were bred in considerable numbers from the pupæ. The parasites began to emerge August 15 and continued to appear during the week following. By August 24 females of *Ichneumon funestus* Cresson and *Ichneumon canadensis* Cresson began to emerge from the pupæ. On August 25 a male of *I. lœtus* was observed to copulate with a newly emerged female of *I. funestus.* The female was resting on an oat straw when the male approached from in front (Pl. 29, fig 2), grasped her quickly by the legs, and at the same time thrusting his abdomen below and clasping the ovipositor with the tip of the abdomen. Copulation was observed three different times and in each case it lasted about one-half minute.

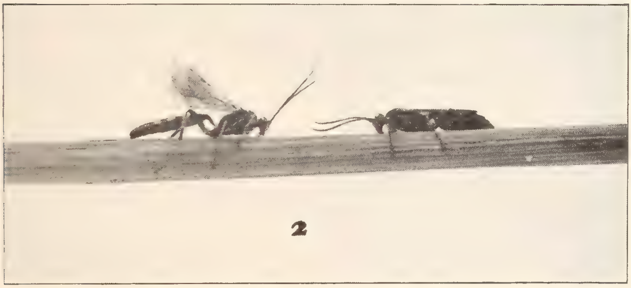
In rearing specimens it was noted that the abdomen of certain females was entirely ferruginous at emergence and then after a few hours acquired the black coloration at the base of the segments. *I. canadensis* and *I. funestus* are separated on the basis of the presence or absence of black at the base of the abdominal segments. A series of specimens shows a gradation of forms from the typical *canadensis* to *funestus.* From these observations it appears that they are females of the same species. The female of *I. lœtus* and the males of *I. funestus* and *I. canadensis* have heretofore remained unrecognized. Brullé (1846) described *I. lœtus* from a male. In a note following the description a female is mentioned and certain points of difference are described. Evidently this female was some other species for both Provancher and Cresson were unable to recognize the female of *I. lœtus.* Say, in 1835 described the male *lœtus* but instead of giving it a new name he referred to it as being the male of a previously described species, *Ichneumon paratus* Say.

It may be concluded from the foregoing breeding experiments that *I. canadensis* Cresson and *I. funestus* Cresson are females of *Ichneumon lœtus* Brullé. Since *Ichneumon lœtus* Brullé has priority over Cresson's species the latter must be considered synonyms.

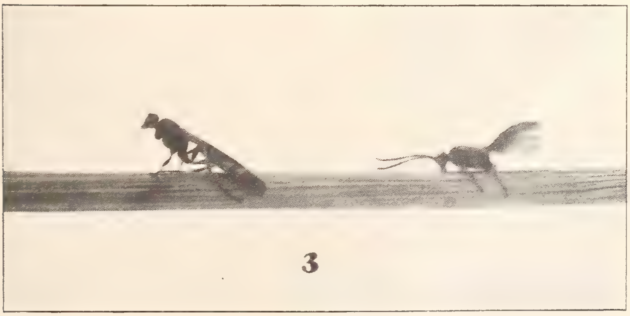
The males of *I. lœtus* have been taken during the winter months in decaying logs. On a warm day last December the writer took a male specimen on the walk in front of the Cornell Insectary. On March 14, 1915, some twenty specimens, all females, were found hibernating

[1] Contribution from the Department of Entomology of Cornell University.

1



2



3

Ichneumon lætus

in a group about eight inches from the surface in a gravel bank. This lot of specimens gives a series showing both the *canadensis* and *funestus* forms. The abundance of the species at this time is undoubtedly due to the unusual numbers of the army-worm during the past summer.

My thanks are due Dr. J. C. Bradley who gave much assistance in the determination of specimens.

SYNONOMY OF *Ichneumon lætus* BRULLÉ

1835. *Ichneumon paratus* Say. (male only).
Bost. Jour. Nat. Hist., I: 228 (LeConte ed.)
1846. *Ichneumon lætus* Brullé (male only).
Hist. Nat. Ins. Hym., IV: 303.
1864. *Ichneumon funestus* Cresson (female).
Proc. Ent. Soc. Phil., III: 166.
1869. *Ichneumon canadensis* Cresson (female).
Trans. Am. Ent. Soc., I: 308.
1875. *Ichneumon hoesitans* Provancher (female).
Nat. Can., VII: 80.
1877. *Ichneumon hoesitans* Prov. =*funestus* Cress.
Cresson, Trans. Am. Ent. Soc., VI: 179.

EXPLANATION OF PLATE 29

Fig. 1. Pupa of army-worm showing the parasite before emerging; male (center) and female of *Ichneumon lætus*.
Fig. 2. Male of *I. lætus* approaching the female.
Fig. 3. Male and female cleaning antennæ and wings.

SOME NOTES ON THE WESTERN TWELVE-SPOTTED AND THE WESTERN STRIPED CUCUMBER BEETLES[1]

By R. A. SELL

THE WESTERN TWELVE-SPOTTED BEETLE (*Diabrotica soror* LECONTE)

The western twelve-spotted beetle (*Diabrotica soror* Lec.) is often called "the western flower beetle" because it is so frequently seen on flowers. Terming it simply "the diabrotica" as they do in some parts of California is not satisfactory, for the danger of confusing it with

[1] This article contains an outline of an investigation made under Mr. E. O. Essig at the University of California during the summer of 1915 (June 20 to August 30). Many difficulties were encountered in the work on *Diabrotica soror* Lec., so that the paper is for the most part a preliminary survey. With *Diabrotica trivittata* Mannerheim it was very different since every observation tended to strengthen the belief that it differs very little from *Diabrotica vittata* Fabricius of the Middle and Eastern States. *Diabrotica soror* Lec. has very little in common with either of the striped forms.

other forms, as the striped cucumber beetle (*Diabrotica vittata* Fab.) or the painted cucumber beetle (*Diabrotica picticornis* Horn), is apparent. In some parts of the country the corn root-worm (*Diabrotica duodecimpunctata* Oliv.) is styled "the diabrotica." As a popular name "the western flower beetle" is fairly satisfactory, for, while it may attack the leaf, the stem or the fruit, it shows a decided preference for the flowers.

Feeding Habits. The insect feeds upon many different kinds of plants; its choice depending upon the locality, the season, or the stage in its life history. In the vicinity of Berkeley it feeds to some extent upon more than five hundred varieties of plants and it is positively harmful or highly destructive to at least one hundred of these.

The flora of this region is especially rich; the range of plant life from the crest of the Berkeley Hills to the bay is very extensive, and the University of California, through the departments of Botany, Agriculture and Landscape Gardening, has introduced various forms of plants from South America, Africa, China, Japan, Australia, Ceylon, Russia and other foreign countries. Counting the native plants, the cultivated plants and those plants that have been introduced for experimental and ornamental purposes they would number several thousand. The following is a list of fifty of the more common and more generally distributed plants upon which the *soror* feeds: beet, bean, pea, marguerite, nasturtium, rose, holyhock, cucumber, pumpkin, muskmelon, watermelon, poppy, alfalfa, sweet corn, potato, pepper, artichoke, tobacco, radishes, mustard, clover, lettuce, eggplant, parsley, plum, apple, pear, peach, cherry, currant, canna, dahlia, foxglove, dandelion, pinks, peony, violet, aster, buttercup, sunflower, black-eyed-susan, primrose, bleeding-heart, lily, burdock, thistle, verbena, morning-glory, wistaria, dog-fennel.

Its work on cultivated flowers is very noticeable, for it makes unsightly holes through the petals and destroys their beauty, but it is no less destructive to the essential organs for it may eat the upper part of the pistil (stigma), dig into the ovary or attack the anthers. Since it is especially fond of pollen and nectar it can frequently be found in a flower doing no apparent damage.

By gnawing holes through the thin and tender parts of the leaves it destroys the foliage and causes a loss of the sap, which is the life blood of the plant, besides interfering with photosynthesis or starch making, a vital process of the plant, and making a way for fungus diseases to attack the injured part.

It sometimes attacks very young cucumbers or muskmelons, the pods of young beans, cauliflower, and the fruits of eggplant and even tomatoes.

A study of the feeding habits of this insect is interesting. It will not eat just any plant and must become adapted to a change of food. Even when confronted with starvation a number of them would not eat the leaves of mullein, thistle, artichoke, pond rushes, dog-fennel, onion tops, red oak, chestnut, maidenhair, pine, spruce or cottonwood. From a diet of beet leaves they did not take readily to eating leaves of maple, peach, plum, cherry, gooseberry, currant, potato or tomato, but finally developed an appetite for them.

After a pair had been fed on beet leaves for several days prickly lettuce was substituted. They did not eat it for two days, then, after a period of six hours from the time they had eaten rather heartily, the male died. In the field prickly lettuce is a perferred host plant of great numbers.

Another pair that had been eating beet leaves were fed apricot peelings. They began eating before night but died the next day.

Ten beetles were fed on beet leaves for six days. After being without food for one day they were given apricot peelings. Six of them died but the other four adapted themselves to the change of diet. After the university had received information of damage to potato tops some experiments in adapting beetles to this food were attempted. Twenty-five beetles that had been eating beet leaves were fed potato tops. At first they would not eat and two of them died. In four days the others had become accustomed to the change. Then they were also given beet leaves but they preferred potato tops. When the potato tops were removed they fasted one day and then resumed the beet leaf diet. None of them died.

Fifty beetles, taken in a beet patch, were fed potato tops. The second day they began to eat and two of them died. After they had been eating well for three days they were fed beet leaves which they would not eat at first. In two days they had adapted themselves to the change.

Under certain conditions this species would eat some part of the flower or fruit of every plant upon which it was observed during the entire period of this investigation.

Occasionally one of the beetles was found in a colony of aphids, walking around among them and gathering up the honey dew but it did not seem to be guided by a sense of smell since numbers of them did not congregate around the bait.

Field Habits. In order to study the range and field habits of this insect large numbers of them were marked by painting with a brush and ink. Several kinds of ink were tried with variable results. White ink and black India ink were fairly successful but red India proved to be the most satisfactory.

Of fourteen beetles marked June 24 from five to ten of them were seen each day until July 1 when eleven were marked. From July 1 to 9 four to fourteen of the twenty-five were seen each day. Of fifty beetles marked July 9 six to twenty-eight were seen each day until July 23. About July 12 great numbers of smaller, more active, light green beetles appeared, which could be readily distinguished from the prevailing form. Of fifty light green beetles marked July 15 one to four were seen each day until July 23. Of fifty light green beetles marked July 22 the record was: 23d four, 24th one, 25th none, 26th one, 27th none.

One male beetle was found every day on a canna for twenty days. Two females were found on a beet plant every day for eleven days. A beetle will leave and return to a favorite plant from day to day where it will frequently spend the night. All the beetles became active about July 20. It was found by marking a large number that they came from the Berkeley Hills down into Berkeley and Oakland.

It seems that there is a period of comparative rest, followed by a period of great activity. Each of these periods must have a definite relation to some stage in the life history of the insect.

Enemies. The tachina fly (*Celatoria diabroticæ* Shim., *Celatoria crawii* Coquillett), mentioned by Mr. Coquillett as one of the natural enemies of *Diabrotica soror* Lec., was not very common in this section of the country this year, for less than twenty examples of it were noted among several thousand beetles.

A spider, unidentified at this time, killed a few of the beetles.

The only birds observed actually eating these insects were the purple finch, the bush-tit, the linnet and the canon wren.

Color Phases. On the 20th of June these beetles were not very plentiful. Their wing covers were the normal leaf-green and the bodies of the sexes were very much alike. By July 12 two color phases could be detected in the field—the normal light green and a yellowish green. By August 1 a third color phase could be detected—a pale faded green. The latter was an old-age type for they soon died. But whether or no it had passed through the other phases of normal green and yellowish green, or represented a frail generation, is an unsettled question.

Eggs. During the mating season females are very heavy with eggs and the abdomens of the males are somewhat enlarged. It appears that the eggs are rather completely developed before mating takes place. At this stage the beetles are ravenous eaters and will stay with one plant almost continuously, seldom leaving it. When attacked these heavy forms simply let all holds go and roll down among the leaves. If they fall to the ground they immediately begin to ascend the plant as if anxious to get back to the feeding place. Before the

mating period they either fly or attempt to conceal themselves on the ground.

The eggs are oval with rounded ends and are rather large for the size of the adult. They are light lemon-yellow and almost transparent. A typical cluster contains four or five. Being rather frail and adapted to moist soil and the surface of the growing plant, they will dry up when exposed to the air.

A number of egg-laying records were kept. The following record of a female, placed in confinement with a male June 24, 1915, is a typical example:

June 24, placed in confinement, one female and one male.

July 13	62 eggs deposited.
July 14	4 eggs deposited.
Aug. 6	61 eggs hatched.
Aug. 18	48 eggs deposited.
Aug. 19	female died.

The first sign of hatching is a dark spot near the end that is attached to the plant. As it develops the shell is rounded out, thereby tending to make the egg shorter and thicker but, as the other eggs are next to it, there are some indentations making it conform to the crowded conditions.

Remedies. Arsenate of lead spray (one ounce arsenate of lead, one gallon water) will kill some beetles and act as a repellent for a few days after it is used. In the experiments tried it killed less than 9 per cent, but it almost relieved the plants from attack for three days.

Bordeaux mixture (unslacked lime 4, copper sulphate 4, and water 50) was tried. It killed 12 per cent in confinement, but in the field it was not as good a repellent as the arsenate of lead spray.

Some experiments were made with a poison bait spray that seems to indicate a remedy worth while, but the data are by no means complete as to how it would work under ordinary field conditions.

The Western Striped Cucumber Beetle. (*Diabrotica trivittata* Mannerheim)

The western striped cucumber beetle (*Diabrotica trivittata* Mann.) is found with the western twelve-spotted cucumber beetle (*Diabrotica soror* Lec.) on pumpkins, cucumbers, squashes, muskmelons, etc., but it is of comparatively small importance. It is closely related to the striped cucumber beetle (*Diabrotica vittata* Fab.) and its habits and life history, so far as they have been observed, are identical, with two exceptions: first, in this locality its feeding habits are more general and, second, it has two generations in a season.

On the "Island Farms" at Alameda the work of the larvæ upon the roots of the cucumber plants was identical with that of the striped cucumber beetle (*Diabrotica vittata* Fab.) in Minnesota.

The adults are not usually of sufficient importance to demand remedial measures, but the larvæ will destroy a patch of cucumbers in a very short time. Eggs are deposited about two inches below the surface of the soil on the tap root of the plant. When they hatch the young larvæ begin working upwards on the root-stalk and appear above the ground in two or three days. Soon the flat sides of the stalk near the corners begin to turn white and the leaves nearest the roots show a white border; then the whole plant begins to wither, the small cucumbers curl and assume awkward shapes, and, if the insect continues, the plant dies.

Tobacco extract, nicotine, is a successful remedy. Various forms of this extract may be had at the drug store, at about two dollars per pound for 40 per cent solution. Counting one teaspoonful of the solution to a gallon of water, a pound can will be sufficient to treat one thousand hills and a man can treat fourteen hundred hills a day.

When the larvæ appear on the stalk, just above the surface of the soil, take a narrow half pint cup and pour the solution carefully against all sides of the stalk in such a manner that it will run down. The solution will kill the larvæ without touching them, but the burrows in the stalk may be very deep—the larvæ will finally work to the pith—in which case a quick splash of the liquid into the burrow would be most likely to kill the insect. Everything depends upon the way in which the liquid is applied. Care and judgment are equally demanded. A good way is to squat down with the cup of liquid in one hand while keeping the other hand free to carefully move the plant that there may be no guess work about where the insect is working and that the liquid may be poured in the right place.

Department of Entomology, University of California,
Berkeley, Cal., August 30, 1915.

LEPTINOTARSA DECEMLINEATA SAY

By W. O. Ellis

During the summer of 1913, while acting as an assistant in the Entomological Division of the Iowa Agricultural Experiment Station, the following record on oviposition was obtained:

From a female captured July 7 and placed in confinement with a male, the writer obtained a total of 1,686 eggs. The experiment continued to September 1, or a period of fifty-five days. On July 28 the

largest number for a single day from this adult was deposited—110 eggs. Girault & Zetek[1] have taken 1,578 from a single beetle.

Date	Number per Cluster				Total
8 July			25		25
9			30		30
10			24		24
12			29		29
14			7		7
15			21		21
19			56		56
24			9		9
28		19	34	57	110
29		22	40	46	108
30		17	42		59
31		10	17	29	56
1 August		10	35		45
2		9	16	25	50
4	12	19	30	36	97
6		42			42
7		34	17	40	91
8		13	39		52
9		10	28		38
11			42		42
12			29		29
13		10	17	41	68
14		13	22	8	43
15		14	21		35
16			26		26
17		20	29		49
18		18	28		46
19		38			38
20		32	9		41
21		11	31		42
22		10	35		45
23			36		36
25		18	13	21	52
26			21		21
27		13	27		40
28			39		39
29			14		14
30			13		13
31			18		18
Total					1,686

[1] Ann. Amer. Ent. Soc., Vol. IV, p. 71.

EXPERIMENTS IN THE CONTROL OF THE POPLAR AND WILLOW BORER (CRYPTORHYNCHUS LAPATHI LINN.)

By Robert Matheson, *Ithaca, N. Y.*

The poplar and willow borer is a serious pest in nurseries of New York state and at present is doing much damage. It is also a serious pest to ornamental poplars and willows, including basket willows. The most extensive depredations of this pest occur in nurseries where large blocks of these trees are grown, and in some cases the annual loss is very considerable. During the past two years, as time would permit, control experiments have been conducted in two of our large nurseries. This work has been made possible through the courtesy of the proprietors, and to them I desire to express my thanks.

Although considerable biological data have been gathered in the course of this work, only the control experiments and their results will be discussed here. Since the publication of Schoene's work in Bulletin 286 of the New York Experiment Station at Geneva very little has been done in reference to this insect. As the result of his work he recommended the use of bordeaux mixture containing an arsenical. This spray should be applied during late July in order to destroy the adults which feed indiscriminately on the bark of the trees. Owing to the difficulty of spraying nursery trees this recommendation has not been adopted, and I know of no experiments which have been conducted on a large scale in order to test the efficiency of this method.

To present the method of experimentation more clearly, a brief synopsis of the life cycle of *C. lapathi* Linn. is necessary. The eggs are deposited in August, September and October in two- or three-year-old stock in the nursery rows. I did not succeed in finding eggs in younger stock. The eggs are laid exclusively in the corky portions of the tree, just below the bark in the cambium layer. They were found most commonly around lenticels, near buds and branches, or in growths caused by pruning. These eggs hatch in late August, September and October. The young grubs feed on the bark and grow slightly before hibernation. In these small chambers, just below the surface of the outer bark, the young larvæ pass the winter. Feeding begins early in the spring, the larvæ attacking the cambium layer and often girdling the trees. In late June they bore into the heart of the trees, forming the pupal cells. Pupation takes place during July and the adults begin emerging in late July and August. The beetles feed for a short time before beginning to oviposit.

Early in my observations I was led to the conclusion that this insect could be destroyed by some contact spray applied to the trunks of the trees in the autumn after the leaves have fallen, or in the spring before

the young larvæ have begun actively feeding. This seemed very reasonable, owing to the quite exposed condition of the young larvæ in their burrows. It seemed to me that some of the emulsions ought to penetrate the outer bark or be absorbed through the very small amount of frass at the entrance to the burrows and destroy them. With this conclusion, I determined to try varying strengths of miscible oils and kerosene emulsion applied both in the fall and spring. In order to secure a stronger penetrating fluid, it was felt carbolineum avenarius ought to be given a thorough trial, but I had to go very slowly as very little is known about the constituents of this preparation. Furthermore, very little is known as to its effects on actively growing or dormant trees.

In the fall of 1913, seventy-six badly infested two-year-old poplar trees were secured and planted at the insectary. On December 1, 1913, part of this block was treated with scalecide at varying strengths and also a few trees with carbolineum and its emulsion[1] as indicated in the table. This experiment was closely watched the following spring but no injury to the trees could be noted, except that the carbolineum treated trees did not seem so vigorous. However, they grew and are now (1915) large healthy trees. Examination and careful count of the burrows in all of the trees was made on June 17, 1914. The number of larvæ present per tree is shown in table I.

TABLE I. *Cryptorhynchus lapathi* LINN.

Treatment	When Applied	Number Trees	Examined	Number Infested	Larvæ per Tree (Average)	Not Infested	Per Cent Infested
Scalecide 1–5[2]	Dec. 1, 1913	10	June 17, 1914	3	2.6	7	30
Scalecide 1–8	"	10	"	4	1.25	6	40
Scalecide 1–10	"	10	"	7	2.3	3	70
Scalecide 1–12	"	10	"	8	1.9	2	80
Scalecide 1–15	"	10	"	5	2	5	50
Carbolineum 1–1	"	2	"	0		2	0
Carbolineum Emulsion 1–2	"	2	"	0		2	0
Check		22	"	10	2.6	12	45.5

In the spring of 1914 a series of experiments was undertaken in a large nursery. Three-year-old stock was chosen as it was the most available at the time of doing the work. Badly infested trees were selected at one side of a large block which had been recently dug. Directly across the roadway was a block of young poplars. On March 31 scalecide, of varying strengths, carbolineum, and carbolineum emulsion were applied to the trunks from the ground up to the young

[1] The carbolineum emulsion was prepared as follows:—1 lb. sodium carbonate, 1 quart hot water, 1 quart carbolineum avenarius. The sodium carbonate was dissolved in the hot water and the carbolineum was then added, stirring vigorously.

[2] All dilutions are with water.

growth. The day was fair but began raining before the various treatments were completed. However, the rainfall was slight so it should not have had any effect on the insecticidal qualities of the preparations.

The treated trees were examined carefully on May 14, 1914. The various treatments had no effect on the growth of the trees, every tree growing vigorously, and there being no difference as far as I could detect between the checks and those under experimentation. In the checks the larvæ were actively at work and their abundance was indicated by the amount of sawdust exuding from the numerous burrows. All the trees treated with different strengths of scalecide showed just as high a percentage of infestation as the checks. This preparation had no appreciable effect. In the trees treated with carbolineum, either pure or as an emulsion, not a trace of infestation could be found. After searching for several hours one shrivelled and blackened larva was discovered in its burrow. However, I did not wish to injure the trees too much by cutting into all suspicious egg punctures.

This experiment was again carefully examined on June 18 and confirmed my previous observations. The checks and those treated with scalecide were nearly all badly infested, many trees with as many as eight to ten borers present, while a few both in the treated and checks were apparently free. Those trees treated with carbolineum and its emulsion were growing even more vigorously than the untreated ones, and not a single trace of the work of the borer in any one of the twelve treated trees could be discovered. These preparations colored the trunks of the trees a beautiful brown, but other than that no injury could be seen.

Fearing that such a perfect control might be due to other causes than the effect of the treatment, a larger series of experiments was planned for the fall of 1914 and spring of 1915. Discarding the miscible oils, kerosene emulsion was given a trial as it has been recommended for the control of the locust borer (*Cyllene robiniæ*). In a block of over 10,000 trees ready for digging in the fall of 1915, rows were selected at the end which showed the greatest amount of the feeding work of the beetles. On December 4, 1914, groups of twenty trees were each treated with pure kerosene emulsion, carbolineum and carbolineum emulsion. Rows were left between for checks. The material was applied directly to the trunks up to the younger growth. On April 9, 1915, twenty-five trees were treated with pure kerosene emulsion, fifty with carbolineum emulsion and twenty-eight with pure carbolineum. Just previous to these treatments the trees in the whole block had been pruned carefully. The material was carefully brushed over the trunks, covering all the cut surfaces of the recently removed branches.

The experiment was examined on June 28. The block as a whole showed a severe infestation, sawdust being present at the base of a

great many trees, and this could be seen for a long distance down the nursery rows. In the rows treated with carbolineum or its emulsion no sawdust could be seen and the trees were vigorous growers, the trunks showing a beautiful brown color but not an indication of borer work. The kerosene emulsion had no appreciable effect, nor did it injure the trees, though it was applied in large quantities. The treatments applied and results obtained may be quickly ascertained by consulting Table II. Kerosene emulsion applied pure in the fall seems to have had some effect but one cannot safely draw conclusions. Thirty per cent infestation is high, though the average number of larvæ per tree is a minimum. The carbolineum applied pure and its emulsion gave almost absolute control and seems to me a very simple and effective means of control under nursery conditions.

TABLE II. *Cryptorhynchus lapathi* LINN.

Treatment	When Applied	Number Trees	Examined	Number Infested	Larvæ per Tree (Average)	Not Infested	Per Cent Infested
Kerosene emulsion (pure)	Dec. 4, 1914	20	June 28, 1915	6	1	14	30
" "	Apr. 9, 1915	25	"	16	2.25	9	64
Carbolineum..................	Dec. 4, 1914	20	"	0	..	20	0
" emulsion.........	Apr. 9, 1915	27	"	0	..	27	0
Carbolineum "	Dec. 4, 1914	20	"	0	..	20	0
" "	Apr. 9, 1915	50	"	0	..	50	0[1]
Check.......................		116	"	56	2.4	60	48.3

The cost of these various treatments has not been ascertained. The carbolineum costs at retail prices $1.00 per gallon, and one gallon should treat at least one thousand to fifteen hundred trees. I am planning to carry on this work on a large scale during the coming year and shall probably treat twenty to thirty thousand trees. In this way the cost of treatment may be determined under commercial conditions.

ESTIMATING THE NUMBER OF GRASSHOPPERS

By E. D. BALL

In most of our published works on injurious insects such terms as abundant, swarming, numerous and common are used to designate the number of individuals concerned in a given attack.

The writer has found that in codling moth work the exact number of worms per tree and per hundred apples, either present or to be anticipated from previous counts, are vital facts in the problem of control, less than one or two worms per hundred apples indicating a good condition—more than the number requiring additional control measures.

[1] One half grown larva was found in July, evidently due to lack of thoroughness in treatment.

In the sugar beet "curly-leaf" studies the actual number of leaf hoppers per beet was found to be closely proportional to the damage done under similar climatic conditions, the difference between one and two hoppers per beet making all the difference between success and failure in crop production in certain cases.

Believing that more definite information would be of value in discussing grasshopper control, the writer attempted to obtain estimates of actual numbers concerned in some recent outbreaks. The results proved to be of more value than anticipated, as by putting egg counts and swarm counts together a better estimate of danger could be given than formerly, and, also, that by using these actual figures the danger was brought home to the people in a way to convince them and arouse them to united action, such as had never before occurred.

It is too bad that we cannot give the actual amount of food consumed per hopper and translate a billion grasshoppers into bushels of oats, bales of hay, or tons of sugar beets.

In estimating the number of eggs laid by a swarm of *Camnula pellucida*, the approximate area infested was determined after discing the breeding ground so that the eggs showed on the surface (the breeding grounds having been located the previous August).

The heavily infested portion was found by counts to average:

To the square inch	175
To the square foot	25,000
To the acre	1,000,000,000

The area in one valley that was heavily infested was about twenty acres or about *twenty billion eggs* ready to hatch. That statement was sufficient to arouse the community, so that sixty teams and men turned out for one day and destroyed them.

The young hoppers start to migrate as soon as hatched and dry, always traveling towards the sun. They travel only on warm days, stopping if it clouds up and becomes cool or rains. In estimating the numbers in one of the smaller migrating swarms, the central part of about three hundred and twenty acres was found to average as follows:

To the square inch	1
To the square foot	150
To the square rod	41,000
To the acre	6,500,000
To the square mile	4,000,000,000

or that part of the swarm equalled two billion grasshoppers. Around this center there was an average of from ten to fifteen to the square foot on about four square miles, or one and one-third billion more, or a total swarm of *between three and four billion hoppers*. This was

considered to be an insignificant swarm as compared to those of 1902, when a total of ten times as many were caught in the county, or two hundred and seventy-four tons. Estimating that five tons were caught from the swarm enumerated above (there was some mixture of swarms) and that they ran about the average catch of eight million to the ton, then this catch of forty million out of the swarm of three thousand, three hundred and thirty million would show that about one hopper in every eighty-seven was caught by balloons. If the same proportion were caught in 1902, and there were less if anything, San Pete Valley had swarms aggregating somewhere near two hundred billion grasshoppers that year.

These swarms were caught for bounty by using "balloons," catching beginning as soon as a swarm was found large enough to pay, which meant the capture of from four hundred to eight hundred pounds per day per outfit. In this way many swarms were caught while the insects were quite small; others were not found until later when they would be larger. Many swarms contained hoppers of all sizes, and finally, late in the season, some catching was done on the breeding ground where only adults were present, so that the average "catch" was probably about half grown. The following table gives the number by weight at different ages:

Approximate Weight of Grasshoppers

	Per Ounce	Per Pound	Per Bushel (60 pounds)	Per Ton
Egg—or just hatched young	95,000	1,500,000	92,000,000	3,000,000,000
One week old	5,000	80,000	5,000,000	160,000,000
¼ to ½ grown—large enough to catch easily	1,000	16,000	1,000,000	32,000,000
Average catch—from small to adult	250	4,000	250,000	8,000,000
Adult females	55	900	50,000	1,800,000
Adult males	115	1,850	110,000	3,700,000

SOME DEVELOPMENTS IN GRASSHOPPER CONTROL

By F. M. Webster, *In charge of Cereal and Forage Insect Investigations, Bureau of Entomology*

During recent years, first the Criddle mixture and soon afterward the poison bran bait, came rapidly to the front as the most practical and efficient measures that could be applied in protecting the crops of the farmer from attacks of grasshoppers which for many years have, with greater or less frequency, over-run his fields and destroyed his crops.

While in many cases—perhaps the majority—excellent results have been obtained by the application of either one of these two measures, nevertheless, it frequently occurred that such results proved entirely unsatisfactory. This has been the case occasionally, even when these poisons were being used in the hands of expert entomologists. It has, therefore, for some time, appeared desirable that investigations be taken up with a view to discovering the determining factor in such failures, as they could not, in all cases at least, be attributed to lack of care in preparing and applying these mixtures.

In fact, very often farmers expected to get results in a few hours, whereas the full effects of the poisons have been found by all of the men conducting these experiments to extend over three or four days' time.

With this situation in mind, experiments were undertaken by four of the cereal and forage insect field stations which together covered a territory extending somewhat interruptedly from the Atlantic to the Pacific coasts.

For upwards of forty years there have been periodical outbreaks of several species of grasshoppers in the Merrimac and Connecticut River valleys in New England, originating in the intervales along the river bottoms. At no time have these outbreaks been satisfactorily controlled and they have, in the past, cost the farmers located in these valleys, immense sums of money. It was with a view to establishing a systematic piece of investigational work that the writer made a survey of the Merrimac valley during the summer of 1914.

The particular species of grasshoppers involved in these New England outbreaks were *Melanoplus atlanis*, *Melanoplus bivittatus*, *Melanoplus minor*, and *Camnula pellucida*, besides one or two other less important species.

With a view of determining whether or not it was possible to control these outbreaks, Mr. Harrison E. Smith was detailed to take up the work in New England, and carry it on during the spring and summer of 1915. One of the first obstacles to be encountered was the rather surprising fact that the young grasshoppers were much more difficult to kill with the poison baits than were those fully developed. The doubling of the amount of fruit used in the poison bran mixture, and adding that ordinarily used in this mixture to the Criddle mixture, eliminated this difficulty to a considerable extent, as the baits with the additional fruit appeared to be more attractive to the young grasshoppers. Still, there were failures even in cases where these poisons were used against full-grown insects, and even now the young up to the third instar do not seem to yield readily to these baits even with the increased amount of fruit and double the amount of the bait ap-

plied per acre. This was puzzling for a considerable time until it was learned that the failure was largely due to the drying out of the baits before the grasshoppers had been attracted to and eaten sufficient of them to be killed from the effects of the poison. This difficulty was eliminated by placing the baits in the fields in the early morning, before sunrise, so that the insects as they began to feed would be attracted by and feed upon the poison. Mr. Smith's work in New England has demonstrated that, over large areas, the experiments in some cases covering six or seven hundred acres, the results were the destruction of 95 per cent of the grasshoppers at an expense of from seven to thirteen cents per acre. With the Criddle mixture, 80 per cent of the full-grown grasshoppers were killed over the entire area of 30 acres at an expense of 6½ cents per acre.

As illustrating the actual results of the use of these poison baits, it may be stated that on a farm near Franklin, N. H., two applications of the poison bran bait resulted, in certain places, in as high as 550 dead grasshoppers in the space of a square foot. Furthermore, some of this work was carried on in pastures where valuable cattle were continuously grazing and in no instance did any domestic animal or bird suffer the least ill effects, so far as could be observed. During the first week of the following September over these treated fields there was not to be found on an average one individual to the square rod.

During the last few years many complaints have been received of attacks of grasshoppers in Florida and recommendations involving the use of these poison baits usually resulted unsatisfactorily, wherever results were reported at all. The species involved was the large "lubber" grasshopper, *Romalea microptera.* Farmers in many sections became discouraged and were convinced that these poison baits could not be used effectively against this pest. Mr. R. N. Wilson, in charge of the field station at Gainesville, Fla., took up the work of determining the cause of such failures. While the actual cause of these failures was not determined, it *was* learned by actual experiments that the poison bran bait, properly prepared and applied would work thoroughly and effectively in destroying these grasshoppers. After carrying out a series of experiments, Mr. Wilson induced five farmers in the vicinity of Fellsmere, Fla., to make careful observations during the following two or three days, and report results. As reported to him, this bait not only attracted the grasshoppers, but killed at least 50 per cent within twelve hours, while these farmers, by placing the grasshoppers in confinement after their having fed on the poison, found that all died within 48 hours. The result of the experiment among the farmers was that, as expressed by one of them: "We now

feel that we have the grasshopper situation well in hand and that, thanks to you, the problem is solved."

Another experiment carried out by Mr. Theodore D. Urbahns at Gustine and San Diego, Cal., resulted equally satisfactorily. In this case the species involved were *M. differentialis*, *M. uniformis*, *M. destructor*, and *Camnula pellucida*. The usual formula was used by Mr. Urbahns, except that 6 lemons were used for each 25 pounds of bran, with 2 quarts of cheap syrup and 3 gallons of water. Mr. Urbahns was able to protect alfalfa fields where the plants were 18 inches high and the insects feeding destructively along the border of the field. In his experiments he found that alfalfa meal was about equal to wheat bran in value, thus giving an alternative where farmers can obtain alfalfa meal more readily than wheat bran, the price being practically the same. Sugar beet pulp was also used but its effectiveness was found to be of shorter duration than that of the bran or alfalfa meal.

Very satisfactory results were obtained with this poison bait mixture by Mr. E. L. Barrett of the Pasadena, California, laboratory in experiments carried out by him in the Imperial Valley, covering two areas, one of about 20 acres, on a ranch at Holtsville; and another of about 10 acres, near Brawley, Cal. Seventy-two hours after the poison was put out, there were found on an average of about 150 dead grasshoppers per square yard. As the effects of the poison would extend beyond that time, it is free to presume that the destruction of these insects were still greater than these figures would indicate.

An attempt to control grasshoppers by these poisons in the vicinity of Tempe, Ariz., was ineffective, and we had a recurrence of the conditions where an expert entomologist failed to secure satisfactory results with the poison. Later, however, experiments were carried out in this same locality, the only difference in the bait being that instead of an ordinary good grade of molasses, sorghum molasses was substituted. Otherwise the same formula was used as that employed by Mr. Urbahns, excepting that 2 gallons of water per each 25 pounds of bran was used in preparing the mixture. The application was made August 12. Two days later the average count over the field was 167 dead grasshoppers to the square rod, while as a final result 95 per cent were killed. Here the species involved was chiefly *Melanoplus differentialis*. Thus it has been learned that the chief cause of failure has been in that, when this poison was used against the young grasshoppers, too small amounts of fruit were utilized in making the bait, and the failures when used against full-grown grasshoppers were largely in that the baits were lacking in moisture and hence less attractive when the grasshoppers began to feed upon them. Then, too, there

seems to be something in the nature of the molasses or syrup used as is evidenced by the results obtained in Arizona.

Perhaps, as indicating the rapid advancement in applied entomology, we might present as a contrast the following extracts from Curiositäten der *Physisch-librarisch-artistisch-historischen Vor- und Mitwelt*, etc., periodical published by Vulpius in Weimar 1811, I, p. 390:

"Aventinus relates the oldest instance in the Bavarian Chronik (p. 302) at the time of King Ludwig IV (reigned 936–954) the large grasshoppers came on the Rhine and devoured cereals, grasses, and vegetation of that kind. The priests held great processions, parading with the sacred objects about the fields, and prayers in the churches, in a word, a great spiritual agitation developed, 'but nothing would help,' adds the chronicler."

"In the 14th century, relates Uland in his writings on the history of poetry and sayings, the Bishops of Thur and Lausanne spoke to the entire church train about the robber fishes, earth worms and grasshoppers. Previously there used to take place a regular trial before the church court with all the rules of jurisprudence, the defendants were called, an attorney was assigned them on appearance, who dealt with the prosecutor, and then only rendered decision."

"As late as 1479 in the Canton of Bern there was great insect damage. The depredators were invited before the church court of the Bishops of Lausanne, to which diocese Bern then belonged, and after trial they were solemnly given the ban in the name of the holy Trinity. The Bern city recorder, who presents this fact, adds that 'it did not help.' "

There are occasions when the use of a hopperdozer is, temporarily at least, profitable, as for instance while the materials to be used in the baits, and which are not always quickly obtainable, are being secured, and when it is desirable to put immediate stop to the work of these pests. A cheap and easily constructed hopperdozer (see fig. 21) has been devised by the farmers of Kansas which may be described as follows: The frame is constructed of two by fours (2 x 6 is better if land is rough and hilly), 16 feet long, with 4 compartments to keep from sloping endwise on side hill land, and the width of a sheet of galvanized iron. Have runner on each end and one in middle, put on with screws; 2 iron loops on each end, 3 or 4 on back side. Make wooden standards 36 inches (or the width of common cotton factory cloth) long to fit in the loops, with shoulder so they will not slip down. Put them in place, then stretch the cloth around two ends and back side and tack in place with large head tacks. The idea of this canvas back is to make pan lighter and when not in use the standards can be pulled out and cloth rolled up and stored in dry for future use. The pan is to be water-tight and with a clevis and singletree hooked to each end runner with horses spread apart; it has a tendency to gather the hoppers into the pan and the idea of a long pan is to get over the most ground, quickly, with least travel. This improved pan is much less expensive than the hopperdozer ordinarily recommended, is much

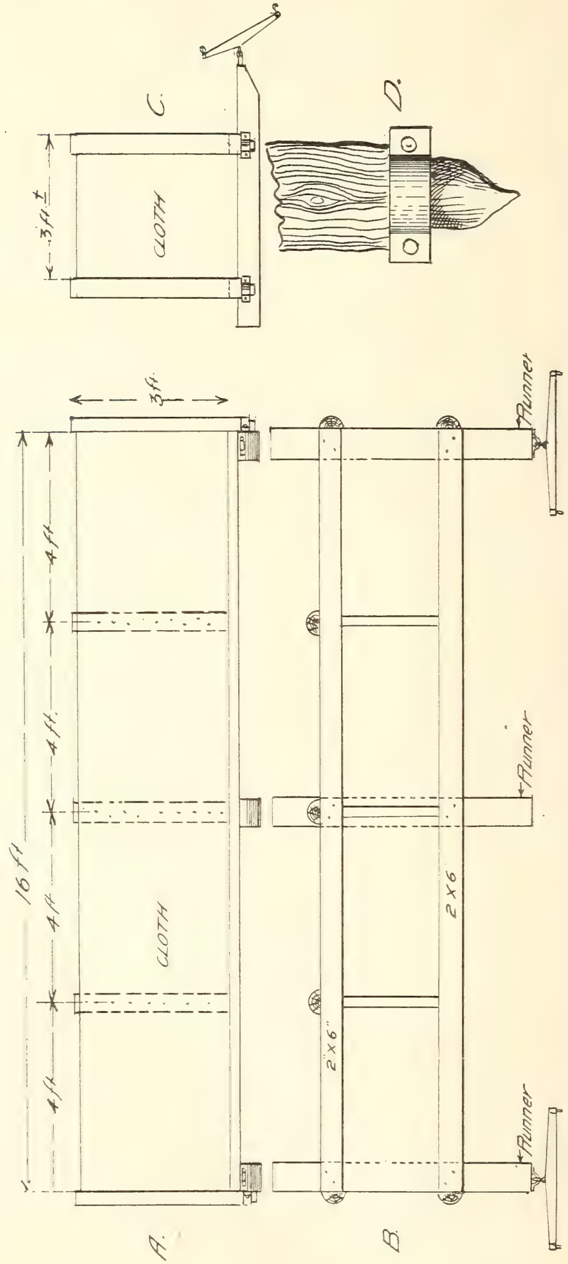


Fig. 21—*A*, Front view; *B*, Plan view; *C*, End view; *D*, Detail of strap fastening for uprights

more easily constructed, and, as has been indicated, when not needed for use it can be folded up and put away until occasion requires its further use.

Entomologists will, the writer is confident, be interested in having a history of the origin of the "Criddle Mixture" by Mr. Criddle himself, and therefore no apologies are offered for including in this paper some notes on the Criddle mixture kindly sent to the writer by the originator of this, one of the least expensive and most useful and effective of our insecticide mixtures.

The origin of the grasshopper bait, christened by the late Doctor Fletcher, "Criddle Mixture," was due to an observation on the part of Mr. Norman Criddle that grasshoppers were in the habit of abandoning all vegetation in favor of freshly-dropped horse dung, this preference being so marked as to leave no doubt in the minds of even the most casual observers. Droppings left several hundred feet in the midst of growing grain at once attracted grasshoppers from the edges of fields so that they might be seen marching steadily towards the direction from which the odor came, and then, having speedily devoured the "droppings," they attacked the surrounding crop with the result that a large bare patch would be made in the midst of it. A few examples such as this seem in themselves sufficient evidence of the substances' attractiveness, but if more were needed the roads and manure piles amply verified what had been observed before.

"The second ingredient, salt, was also added through observation. It is well-known that clothing and the handles of any farm implement will attract grasshoppers on account of the salty taste, caused through contact with the human skin, while experiments supplementary to this observation showed that they readily ate any article steeped in salt water. For this reason salt was added and proved particularly valuable after the droppings became dry.

"The third ingredient was largely a matter of cost and convenience. Paris green, arsenic or arsenite of soda would doubtless prove equally successful as a killing agent, and Paris green was selected on account of its availability in sufficient quantity. After numerous experiments the following formula was adopted as most suitable:

Horse droppings, preferably fresh, by measure one hundred parts;

Paris green, one pound or part;

Salt, one pound or part."

"This approximates 15 gallons by measure of horse manure to one pound of Paris green and salt. It may be mixed in two ways, namely, dry with sufficient water added to make a thoroughly moist, but not sloppy, mash; or by placing the Paris green and salt in water first and pouring this over the 'droppings.' Before application it is necessary to pay some attention to weather conditions, cloudy days, or those in which the temperature is below 60° F., should be avoided and preference given to those in which sunshine and heat predominate. In applying it the best method seems to be to scatter it thinly among the grasshoppers every few days. It can, however, be put out in small heaps, in which condition its attractiveness lasts longer but it is more dangerous to stock.

"There is no doubt whatever as to the remarkable attractiveness of this mixture at all periods, from the time of the locusts' appearance in May until they die in September, or of its superiority over any other form of extermination yet tried in these parts. The evidence of farmers is almost unanimous on this point, and all the best type speak with enthusiasm of its value, the few exceptions being due to faulty methods in its application and mixture. My brothers and I have also used it con-

tinuously for the last ten years with perfect success and at very small cost, the last occasion being this season when we undoubtedly saved many acres of crop, while on more than one occasion its use undoubtedly saved the whole crop as was shown by the destruction of those not treated.

"This, however, refers only to Manitoba, as my experiences have been but casual outside, but I am of opinion that climatic conditions, particularly humidity, play an important part in the success or failure of this mixture. From a few observations made in Quebec some years ago, I found horse dung far less attractive there, and the roadways, which in Manitoba would be swarming with locusts, were comparatively free. Judging from this, I would expect to find it valueless in the moister parts of Canada and the United States, and most useful in the dryer Northern States, particularly the Dakotas, Minnesota and Montana, as well as Alberta, Saskatchewan and Manitoba.

"Why a mixture so attractive in Manitoba should prove useless in Quebec in a time of drought with the same species of grasshopper involved, is difficult to answer. That it is so there seems no doubt, and the problem is therefore to ascertain, with accuracy, what the conditions are and where the conditions are favorable or otherwise. I should consider a trustworthy indication would be to watch the freshly-dropped dung and roadway. When this is eaten freely, the mixture should prove a success, when grasshoppers are not so attracted, it will prove a failure.

"It may not be out of place to remark in conclusion that stable water from behind the stalls is even more attractive than dung and has proved a remarkable attractant when mixed with other material such as bran or sawdust, while grasshoppers have been observed to actually devour the earth in places where it has been left. Dry cow dung is also readily devoured."

While it will be observed from the foregoing that it has been entirely practicable to destroy from 75 per cent to 95 per cent of the grasshoppers present in given areas, thus showing that these methods perhaps offer the greatest protection to a majority of farmers and ranchmen, there are cases where, owing to a variation in existing conditions, other precautions must be taken. These insects deposit their eggs in waste lands, in many cases lands that owing to their nature it is impossible to bring under cultivation. Myriads of young are produced and develop in such breeding grounds and continue to migrate therefrom for a considerable period of time, so that the destruction of even 90 per cent of the grasshoppers present at any one particular time frequently does not offer entire protection to the farmer. Therefore other measures for destroying these pests must not be overlooked.

During the past season several owners of large areas in New Mexico tried discing, harrowing and other methods of shallow culture during fall or winter to destroy the eggs. Spring culture of this character will not destroy the eggs. While of course winter culture cannot be carried out in the northernmost part of the country, it is entirely feasible in many sections of the South, where grasshoppers prove a grievous pest. And in the northern part of the country many areas of waste land can be disced or harrowed or otherwise stirred in the fall to a depth of two or three inches.

One of the most striking examples of the advantages of this method that has come to our notice during the past season was in the case of a farmer in the vicinity of Wagonmound, New Mexico, who had made a practice of discing all his ditches, fence rows, and other waste places on an extensive alfalfa farm, as well as discing alfalfa itself. During the summer of 1915 there were very serious ravages of grasshoppers in that neighborhood but this farm almost entirely escaped grasshopper attack. If this were a single instance it might be termed a coincidence, but all through that country, where waste areas were treated in this way during fall or winter, it was very easy to pick out such later on during summer on account of the slight damage done by the grasshoppers.

The greatest objection to methods of this sort is, however, the difficulty in arranging for a thorough coöperation. If farmers over a considerable area would all combine and go over the waste lands where possible with disc harrows, or even other harrows, and cultivate to the depth of a couple of inches, they would derive a vastly greater benefit than would seem possible. In fact if this method of treating waste lands were followed during the fall or winter where possible, supplemented the following year by the use of poisoned baits, it is doubtful if any one need suffer seriously from the attacks of grasshoppers in any section of the United States.

SOME STUDIES ON THE SNOWY TREE-CRICKET WITH REFERENCE TO AN APPLE BARK DISEASE

By P. J. Parrott, W. O. Gloyer and B. B. Fulton

Recent years have been characterized by great activity in the study of insects as carriers of human and animal diseases. A cursory perusal of literature suggests that much less attention has been directed to the rôle that these agents play in the dissemination of disorders of plants. Observations of the snowy tree-cricket (*Œcanthus niveus* D.G.) on apples have indicated that the investigation of the activities of this species on this host would prove a fruitful problem for study and furnish a contribution to the knowledge of this somewhat neglected field.

One who has noticed the work of *Œ. niveus* on apple can hardly fail to form the opinion that this species is in some way connected with the spread of a bark disease of this fruit. Even to superficial observations, that there is a relationship between this insect and some parasitic organism, is plain and unmistakeable. The opinion that there is some such association is formed from the fact that the tissues about

the wounds in the bark produced by the insect are much discolored or dead. The diseased areas range generally from one-fourth of an inch to an inch in diameter, while the bark within these limits varies from purplish or reddish-brown to pale brown, depending apparently on the extent and age of the infection. Usually most of the affected spots are circular or somewhat oval in form, and occasionally there is a large irregular extension of the original infected area as if there had been a renewal of activities by the infectious agent. The bark within the area of infection is generally slightly depressed and may also be separated from the sound bark by a distinct line or narrow crack. In more advanced stages cracks develop, separating the dead area from the surrounding living tissues, and there is formed a core which adheres loosely to the wood, affording attractive situations for the woolly aphis. From the wounds made by the insect, located as a rule in the center of the diseased areas, one may observe in April or May more or less flowing of a gummy, reddish-colored liquid, which on drying leaves a resinous product about the orifices of the punctures. In their external appearances and effects these cankers resemble superficially certain stages of the New York apple-tree canker (*Sphæropsis malorum* Pk.) or the blight canker of apple trees (*Bacillus amylovorus* (Burr.) de Toni).

Our investigations on the tree cricket with reference to this disorder of apples have been along three lines, (1) to identify the infectious organism of the apple bark, (2) to ascertain the habits of the tree cricket to determine in what ways it may act as a carrier of the disease and (3) to make experimental attempts to reproduce the disease in apples by using the crickets as carriers of the spores. These studies were conducted jointly by the Departments of Botany and Entomology of the Geneva Station, the former department directing the work involving the determination of the fungi and the cultural and experimental operations with the disease organisms.

Identification of Causal Agent of Bark Disease

The primary steps in this coöperative effort involved the determination of the causal organism, which was essential before there could be a really intelligent understanding of the exact rôle of tree crickets in the dissemination of the disease. Cultural and microscopical studies conducted to this end have revealed the interesting fact that the causal agent of the bark trouble in New York was, in the majority of cases, neither the New York apple canker (*Sphæropsis malorum*) nor the fire-blight canker (*Bacillus amylovorus*), as formerly supposed, but a species known as *Leptosphæria coniothyrium* (Fckl.)

Sacc. (*Coniothyrium Fuckelii* Sacc.). According to Duggar[1] this is a fungus which, as a disease-producing organism, has been known only a few years. O'Gara[2] lists it as occurring on apple and rose at Washington, D. C., and on apples in a nursery near Clemson College, S. C. It is stated by this writer that most of the infections took place where the bark of the trees had been bruised or slightly broken by the tools or harness in cultivating. He also records that in one nursery serious infection was found on apple trees which adjoined a clump of wild roses badly infected with the disease. The trees nearest the roses showed the greatest number of infections. In New York this fungus had, up to the time of this investigation, attracted no attention either as an apple or as a rose pest, but since 1899 it has been regarded in this state as a widespread and serious disease of raspberries, which is known as Raspberry Cane Blight. It is essentially a wilt disease, and the principal damage results to the fruiting canes. The whole cane may be involved or only a portion of it. As to the manner of infection Clinton[3] thinks that the fungus gains entrance through the flowers and fruit, the spores being apparently spread by bees and other insects. Stewart,[4] as a result of his extensive and careful studies of the disease, believes that infection occurs in wounds of various kinds and that a break in the epidermis usually precedes the attack. He also states that cane-blight often starts in wounds made by the "heading back" of new canes, by the removal of branches, by the rubbing of canes against each other or against supporting wires, and particularly in crotches where the branches are more or less split apart, and in wounds made by the snowy tree-cricket *Œcanthus niveus* (*nigricornis*) during oviposition. "The wounds thus made furnish a lodging place for *Coniothyrium* spores and also for water necessary to the germination of the spores, making the conditions exceptionally favorable for infection. That infection does actually occur in tree-cricket wounds is shown by the large number of instances in which the cane is covered with *Coniothyrium* pycnidia in the vicinity of the wounds, usually just below them. The well-known tendency of cricket-injured canes to break at the point of attack is probably due, in part, to brittleness induced by the *Coniothyrium*. It appears that the injury done by the tree cricket is often much aggravated by the cane-blight fungus. While *Coniothyrium* often takes advantage of wounds it is by no means certain that it should be classed as a wound parasite." As to the methods by which it is distributed, Stewart suggests the dissemination

[1] Duggar, B. M., Fungous Diseases of Plants, p. 354.
[2] O'Gara, P. J., Phytopathology, Vol. 1, p. 100, 1911.
[3] Clinton, G. P., Conn. Exp. Sta., Report (1906): 321–324.
[4] Stewart, F. C., N. Y. Ag. Exp. Sta., Bul. 226, pp. 331–366.

of infested plants through the nursery trade and the carrying of spores by wind and rains, or by pickers or workmen in pruning the vines. The suggestion is also made that birds and insects carry the spores to a limited extent. The fact that the blight is so abundant and destructive to raspberries and that, while the tree crickets occur in great numbers on raspberries, they prefer apple wood for oviposition is additional presumptive evidence, tending to support the theory that these insects have a hand in infecting apple trees with the disease.

Certain Habits of Tree Crickets which Favor Dissemination of the Bark Disease

In the absence of definite data as to the actual part played by the insects in the dissemination of this trouble, it appeared from the start that two habits of tree crickets should be carefully studied, which are, (1) their feeding habits, and (2) their oviposition habits. Tree crickets are omnivorous creatures and subsist on a diet of wide assortment. In their early life they feed extensively on plant lice, leaf-hoppers, tingitids and scale insects. At times they also exhibit cannibalistic tendencies, directing their attacks to the tips of the folded wings or to portions of the abdomens of one another, while those offering feeble resistance may be devoured outright. As the insects approach the mature stage, they develop more pronounced phytophagous and mycophagous habits, feeding on the floral organs of various plants, on foliage, on fruits of different sorts, and such minute fungi as may be found on bark or decaying vegetation.

The snowy tree-cricket oviposits in a great variety of plants, among which may be mentioned apple, plum, cherry, walnut, raspberry, elm, peach, witch hazel, chestnut, butternut, wild crab-apple, hawthorn, red oak, maple and lilac. The largest numbers of eggs have so far been found in apple, plum, cherry and elm. The areas selected for the reception of the eggs varies according to the variety of plant and the age of the wood. With the raspberry, the eggs are inserted at the sides of the buds in the fleshy parts in the axils of the leaves but they do not extend into the pith, while with the elm the eggs may be most commonly observed in the corky areas and they do not as a rule reach the soft inner bark. In the case of other trees, especially the apple, deposition on the smaller branches occurs about the thickened bark at the bases of the twigs. With older wood, the eggs may be found about all areas of the bark, and frequently they are inserted through the lenticels and are placed in the inner soft bark. In making a hole for the reception of the egg a groove is sometimes cut in the surface of the underlying wood, but the female generally avoids drilling to any appreciable distance in such hard structures.

The process of egg deposition is briefly as follows: The female, having selected a suitable spot on the tree, first gnaws a hole in the bark. She then advances forward, and moving the ovipositor at right angles to her body, inserts the tip of it in the wound and proceeds to bore the hole for the reception of the egg. The drilling is accomplished by a thrusting and rotating motion of the ovipositor. After boring to a suitable depth, the egg is deposited. An adhesive substance is then discharged, which is kneaded about the egg by the ovipositor. Attention is also called to the curious habit of the female which, at the conclusion of the drilling operation, usually defecates and then, when the egg is deposited, conveys the excreta by means of her mouth to the wound and gently kneads it to form a neat cap to the opening.

In studying the feeding and oviposition habits of the snowy tree-cricket it appears that infection of apple bark might take place as a result of (1) wounds produced by the gnawing of the bark by the female as the initial step in the act of oviposition; (2) by means of the ovipositor, the adhesive substance discharged at the time of deposition, serving to collect and to hold the spores which may later be left in the holes during the drilling process; and (3) by the introduction of spores in the oviposition wounds on account of the remarkable habits of the insect, which employs its excreta to close the openings in the bark after the deposition of the egg. Our attention has largely been devoted to the consideration of the last point, which has involved a study of the viability of the mycelia and spores of fungi after passage through the intestinal tract of a number of the crickets and experiments in the orchard using tree crickets as carriers of the spores of several of the more important bark diseases of the apple.

In our work to determine the effects of the digestive processes of the insects upon the vitality of the spores the following methods were employed: Tree crickets to the number of twelve to twenty individuals were confined in breeding cages containing raspberry shoots and apple twigs which were abundantly infested with plant lice. Spores of various fungi were introduced into the breeding cages in a 5 per cent cane-sugar solution which was atomized over the foliage or through sections of wood which were affected by some of the common bark diseases. At varying intervals of time microscopical and cultural studies were made of the excreta to classify the different species of spores in the alimentary wastes and to determine their viability in ordinary agar cultures.

Some of the more interesting results obtained in these tests may be briefly summarized as follows:

1. The crickets fed readily on diseased areas of apple and raspberry canes, even when foliage and lice were abundantly

supplied. In one cage containing cankers of the New York apple canker, *Sphæropsis malorum*, and spores of the blister canker *Nummularia discreta* Tul. applied to foliage, an examination of fifty pellets showed twelve pellets without spores of either fungus; twenty-eight pellets with spores of the New York apple canker, and twenty pellets with spores of the blister canker. In many instances spores of both diseases were found in the same pellets.

2. When crickets were starved two days before feeding, spores of various fungi passed through the intestinal tract in a period of six and one-half hours.

3. When tree crickets were allowed to feed normally before the tests, spores of various fungi, including the New York apple canker and blister canker, were found in the excreta four days after diseased wood was removed from their diet.

4. Cultural tests of spores in the excreta showed that spores of the New York apple canker and the Mica Inky Cap (*Coprinus micacious*) passed unharmed through the intestinal tracts of the crickets. Spores of the blister canker showed poor germinating qualities. The feeble growth of the stock cultures suggests that the spores possessed low vitality, which may be explained by the fact that they were taken from museum material nearly one year old. The excreta of these insects possess a rather extensive flora, which includes such forms as *Penicillium*, *Alternaria*, *Pestalozzia*, *Asperillus*, a *Myxomycete*, and many bacteria and yeasts. Most of these showed a high rate of germination after being subjected to the digestive processes of the tree crickets.

5. In twelve attempts to establish the New York apple canker, the *Coniothyrium* canker and brown rot (*Sclerotinia fructigena* (Pers.) Schrœt.) in peaches and apples, all proved failures except in one experiment where there were three slight infections by the *Coniothyrium* canker. On account of the readiness with which the insects feed on the spores and the abundance of these organisms in the excreta, it would appear from the work already accomplished that conclusive experimental proof of such carriage of bark diseases ought not to be difficult to demonstrate, especially with a better understanding of the conditions favoring inoculation and incubation, to which plant pathologists are now devoting considerable attention.

While the foregoing data dealing with the viability of spores of various bark diseases after passage through tree crickets are new, it should be stated in conclusion that the existence of pathogenic microörganisms in the digestive tract of insects and their degrees of resistance to the

digestive processes of various forms of animal life have been discussed by other writers. House-flies captured in the open are said to show a great variety of spores. Dr. Graham Smith states that feces, deposited by flies, contain organisms in considerable numbers for at least two days after feeding by the insects and that they are frequently infective for much longer periods. Anthrax spores, according to this writer, survive for many days on the exterior of the insect as well as in the alimentary canal. Some writers maintain that the danger of disease germs that pass through the body of the common house-fly is greater than from those supposed to be carried from foul substance on their feet. Studies on the *Fusarium* rot of corn showed that the germinating powers of this disease were little or not affected when subjected to the digestive processes of chickens. The studies by Morse on potato scab indicated that the spores of this disease are able to pass through the digestive tract of both horses and cows and go into the manure pile without being destroyed, but much more readily with the former than the latter. The manure of horses is very likely to carry the germs of this disease. Similar views are held by plant pathologists generally with respect to corn smut, cabbage club-root, and other plant diseases.

A NEW SPECIES OF GONATOCERUS (MYMARIDÆ) PARASITIC ON THE EGGS OF A NEW SPECIES OF IDIOCERUS (BYTHOSCOPIDÆ) FEEDING ON POPLAR

By M. D. Leonard and C. R. Crosby, *Ithaca, N. Y.*

On May 29, 1914, a resident of Ithaca brought to the Insectary some poplar branches badly infested with nymphs of a Bythoscopid. No further opportunity was presented for the study of the insect until the spring of 1915 when, on April 1, we procured some small branches from the infested trees and placed them in water in a warm room in order to force out the buds. The eggs began to hatch on April 19 and the first adults were obtained on May 14. The insect was at first thought to be *Idiocerus alternatus* Fitch but, owing to discrepancies between the life history of that insect as described by Osborn and Ball (Iowa Agr. Exp. Sta. Rept. for 1897, p. 118) and the life history of the species under discussion, we were led to question the determination. Prof. Herbert Osborn has kindly compared our specimens with those in his collection and informs us that he is of the opinion that they represent an undescribed species.

Idiocerus gemmisimulans new species.

Female. Length, 7 mm. Vertex yellowish with a dark brownish irregular line connecting the eyes along the crest; the usual spots on the vertex indicated by two small more or less indistinct brownish dots; vertex mottled with brownish, especially at the inner upper angle of the eye and in the center where it is more or less bluish in certain lights. In the darker specimens a broken irregular dark brownish procurved line connects the antennæ. Ocelli situated on dark brownish spots. Face pale yellowish. Sculpture of vertex finely, transversely rugulose. Basal segment of antennæ yellowish, second segment blackish, remainder yellowish to dark brownish. Prothorax with bronzy reflections, brownish, sometimes mottled with bluish, transversely rugulose; sculpture more pronounced than on the vertex. Scutellum brownish, paler behind, rugulose in front of the depressions and transversely striate behind. Wings pale brownish, veins with alternating dark brown and white portions. When the wings are at rest the following white portions of the veins are most conspicuous: terminal portion of *2d A* (which when the wings are closed makes in combination with the white vein on the opposite wing a conspicuous V-shaped mark); a section near the base of *Cu* opposite the fork of *R;* the fork of *R;* and the junction of *Cu2* and *1st A*. Legs brownish yellow; tibiæ with a more or less distinct dark brownish stripe extending along the basal half of the outer edge. Claws blackish. Ventral aspect of insect yellowish.

Male (Pl. 30, Fig. 6). Length, 6 mm. Coloration of head similar to that of female. Prothorax slightly more grayish with two irregular blackish spots in center and one on either side on posterior border. Scutellum yellowish brown with a blackish bar in front notched in the center behind, and nearly interrupted by two large areas of the ground color; behind this bar are two small blackish spots. Membrane of wings for the most part pale brownish, more pronounced at tip, veins with alternating whitish and dark brownish or blackish portions. The extent of the dark brownish portions on the wings varies to a considerable extent but is often as shown in Pl. 31, Fig. 10. The markings on the wings are more distinct than in female. Antennæ and legs similar to those of the female. Antennæ without discs. Face of the male (Pl. 31, Fig. 9) similar to that of female. In the lighter specimens the mottling on the vertex, which in the darker specimens often forms a more or less distinct band connecting the eyes, is very faint, and the procurved line connecting the antennæ lacking.

Egg (Pl. 30, Fig. 7). Length, 1.36 mm., width, .4 mm., bluntly rounded at posterior end, tapering gradually to anterior end which is obliquely truncate and provided with a dark brownish cap; pale translucent, shiny; chorion finely punctate.

The eggs (Pl. 31, Fig. 8) are inserted in groups of five to ten, eight being a common number, just under the bark of the green twigs, usually just above a bud. The eggs lie flat in a more or less curved row under a thin flap of bark which soon turns brown.

NYMPHS.

Stage I (Pl. 30, Fig. 1). Length, 1.29 mm., width of head including eyes, .63 mm. General color shining dark brown or black. Head with a narrow yellowish median line. Thorax with a broader yellowish median line of varying width. First and second abdominal segments yellowish; the latter brownish laterally. Eyes reddish. Antennæ pale yellowish, except basal segment which is black. Coxæ, trochanters and extreme base of femora pale yellowish; remainder of femora and basal half of tibiæ dark brownish or blackish; terminal half of tibiæ and first tarsal segment pale yellowish; whole of second segment of fore tarsi, and tip of second segment of middle and hind tarsi, blackish; claws blackish.

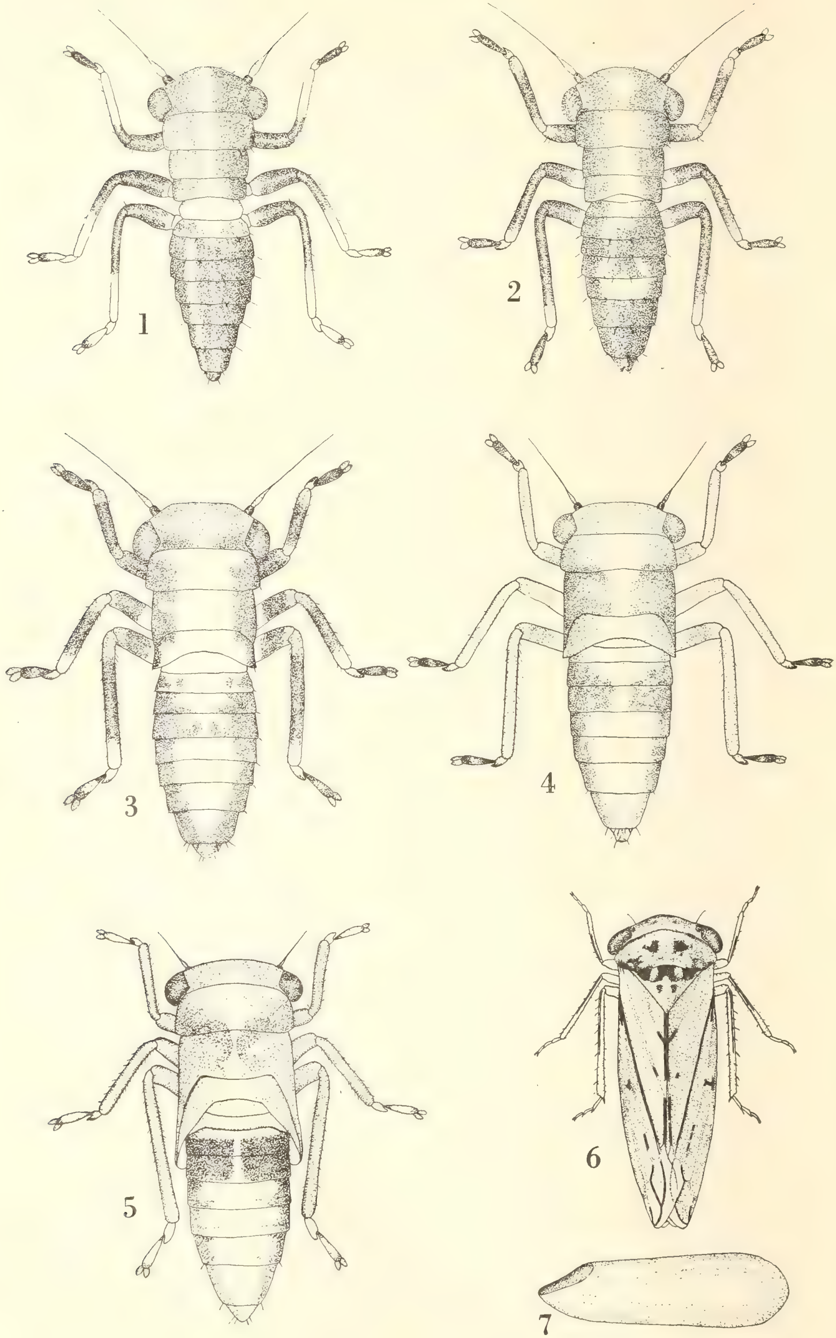
Stage II (Pl. 30, Fig. 2). Length, 1.98 mm., general color dark brownish to blackish. A pale yellowish median stripe, varying in width, extends from near the vertex back to the middle of the third abdominal segment. Segments five and six of abdomen yellowish in center. These yellowish markings vary considerably in extent and distinctness in different individuals. There is also a pale yellowish line on the head bordering the inner margin of the eyes. Eyes reddish. Antennæ pale yellowish except basal segment which is blackish. Coxæ, trochanters, extreme base of femora and tip of middle and hind tibiæ pale yellowish or whitish. Tip and base of fore tibiæ and tip of fore femora light brownish. First segment of tarsi whitish or slightly tinged with brownish; second segment of tarsi blackish; claws light brownish.

Stage III (Pl. 30, Fig. 3). Length, 2.61 mm., width of head including eyes, .85 mm. In this stage the general color is somewhat lighter than in the two preceding stages and the yellowish median stripe is considerably broader. It varies in extent and width but is usually about as shown in the figure. Head wholly tinged with brownish, with dark brownish or blackish on caudal margin inside eyes. Eyes and antennæ as in preceding stage. Legs dark brownish or blackish except for the following parts: coxæ, trochanters, extreme base of femora, and tip of middle and hind tibiæ and first tarsal segment, pale yellowish; tip of fore tibiæ, tip of femora, base of tibiæ, center of second tarsal segment, and the claws, light brownish. Metathoracic wing-pads extend back to second abdominal segment and mesothoracic wing-pads noticeably produced backward.

Stage IV (Pl. 30, Fig. 4). Length, 3.88 mm., width of head including eyes, 1.57 mm. Markings variable but in general as shown in figure. Paler than in preceding stage being rather light brownish. Head pale brownish. Median yellowish area broad on prothorax, narrowing on mesothorax, then wider on metathorax. Laterad of this area on the pro- and metathorax pale brownish, on mesothorax dark brownish. Abdomen with two large yellowish areas narrowly connected on the median line, bordered laterally with dark brownish. Eyes and antennæ as in preceding stage. Legs yellowish brown, femora paler at base and tip. Fore tibiæ tinged with dusky except at base. First tarsal segment yellowish tipped with dusky; second segment dark brownish or blackish, lighter in middle; claws brownish. Wing-pads extend back nearly to third abdominal segment.

Stage V (Pl. 30, Fig. 5). Length, 4.9 mm., width of head including eyes, 1.98 mm. Head pale brownish. Prothorax yellowish or brownish yellow, hind angles darker; mesothorax brownish except a yellowish median portion and a yellowish spot on either side of this, as shown in figure. Metathorax yellowish in center as in preceding stage; wing-pads pale brownish. First two segments of abdomen brownish yellow, remainder of abdomen yellowish except the lateral margins of segments five to nine which are dark brown and a blackish band interrupted narrowly along the median line and including the posterior two-thirds of segment three and the whole of segment four. Antennæ and eyes as in preceding stage. Legs light brownish; first segment of tarsi yellowish, second segment at base and tip, and the claws, tinged with brownish. Wing-pads extend back to middle of fourth abdominal segment.

Until about the fourth stage the nymphs remain feeding on the leaves. In the fourth and fifth stages they are found on the smaller twigs resting usually with the head directed towards the base of the branch. In this position they bear a striking resemblance, both in form and color, to the buds of the poplar.



Idiocerus gemmisimulans

Described from thirty-four adult specimens—thirteen females and twenty-one males. Reared on the common poplar, *Populus deltoides* Marsh, and from Lombardy poplar, *Populus nigra italica* Du Roi, at Ithaca, N. Y. The descriptions and drawings of the nymphal stages were made from living specimens. Types in the Cornell University collection.

This species is most closely related to *I. lachrymalis* Fitch, from which it may be distinguished by the fact that the antennæ of the males lack discs, the absence of the spots on the face, the less distinct spots on the vertex, and the presence of a blackish line on the tibiæ.

THE EGG-PARASITE. On May 20 it was noticed that parasites were emerging from the eggs of Idiocerus through a small round hole in the bark overlying the egg-clusters. Six specimens were secured of which four were females and two males. This species is apparently undescribed.

Gonatocerus ovicenatus new species.

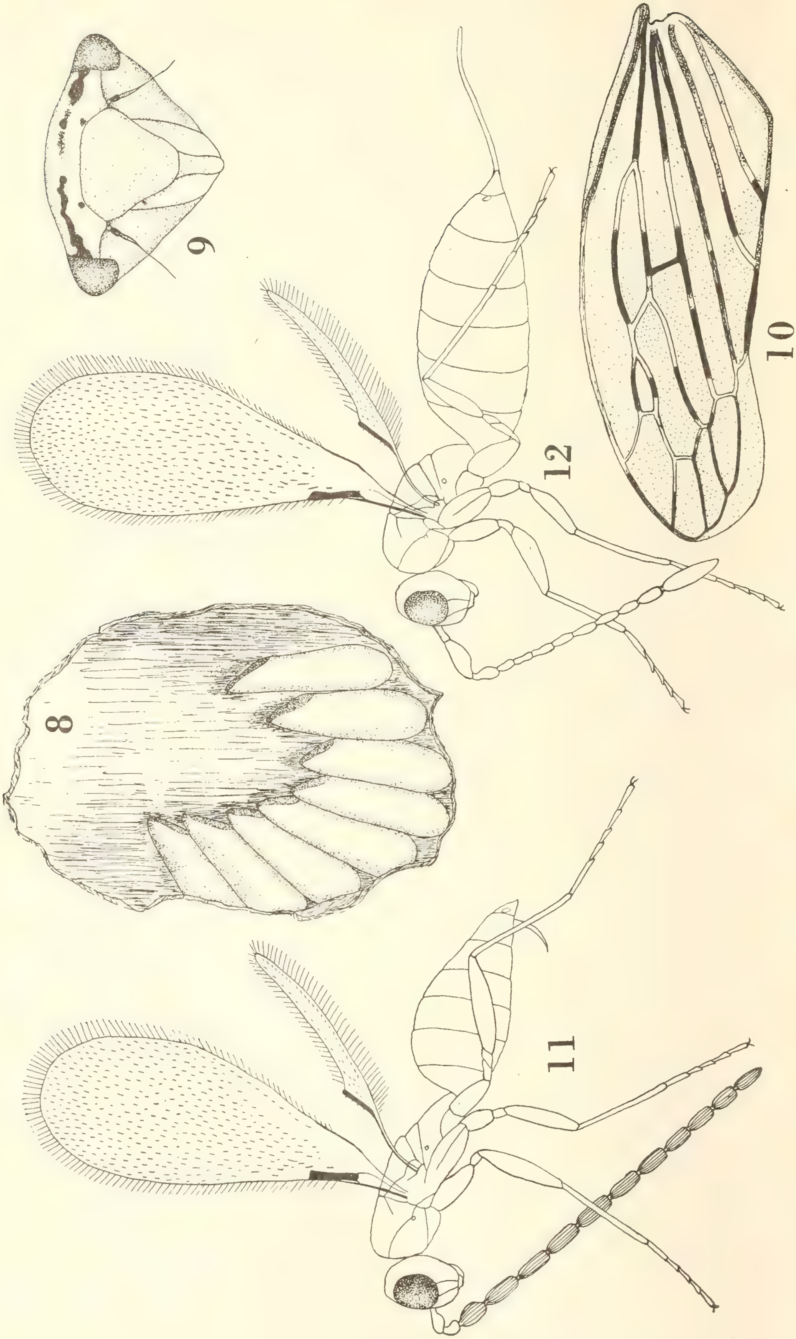
Female (Pl. 31, Fig. 12). Length, 1 mm., ovipositor, .36 mm. General color black, the eyes dorsally and posteriorly narrowly margined with white. A broad band on the vertex connecting the eyes and including the ocelli, whitish. Thorax and abdomen uniform black. Ovipositor black, distal third bent slightly downward. Antennæ brownish, radicula slender, one half as long as the scape. The scape is compressed, widened below, the articulation with the radicula marked by a whitish band; pedicel obconic. The relative length of the segments of the antennæ is indicated by the following ratio: radicula and scape, 36; pedicel, 18; funicle segments 10, 12, 16, 15, 18, 17, 16, 16; club 40. Legs blackish, base and tip of front femora, front tibiæ, and tarsi of all the legs paler; terminal tarsal segments darker than basal segments. Wings hyaline. Front wing one-third as wide as long. Length of longest marginal cilia about one-fifth width of the wing.

Male (Pl. 31, Fig. 11). Length, .9 mm. In color similar to the female. Whitish markings on the head as in the female. Antennæ brownish, thirteen segmented. The relative length of the segments of the antennæ is indicated by the following ratio: scape 15; pedicel, 10; funicle segments, 20, 25, 24, 20, 22, 25, 25, 25, 22, 23, 22. Scape short, rounded below; pedicel broadly obconic; first funicle segment broader than succeeding segments; the segments of the funicle coarsely ridged longitudinally.

Described from four females and two males, reared at Ithaca, N. Y., from the eggs of *Idiocerus gemmisimulans* Leonard and Crosby, May 20, 1915. Types in the Cornell University collection.

According to Girault's table to the species of Gonatocerus (Trans. Am. Ent. Soc., 37: 273), this species would run fairly well to *G. maga* Girault, from which it may be distinguished by the antennal characters given above.

Our thanks are due to Professor Osborn for examining our specimens of Idiocerus and comparing them with specimens in his collection.



Idiocerus and Gonatocerus

EXPLANATION OF PLATES 30 AND 31

Fig. 1. Idiocerus gemmisimulans, first stage nymph.
Fig. 2. Idiocerus gemmisimulans, second stage nymph.
Fig. 3. Idiocerus gemmisimulans, third stage nymph.
Fig. 4. Idiocerus gemmisimulans, fourth stage nymph.
Fig. 5. Idiocerus gemmisimulans, fifth stage nymph.
Fig. 6. Idiocerus gemmisimulans, adult male.
Fig. 7. Idiocerus gemmisimulans, egg.
Fig. 8. Idiocerus gemmisimulans, cluster of eggs in position.
Fig. 9. Idiocerus gemmisimulans, face of male.
Fig. 10. Idiocerus gemmisimulans, wing of male.
Fig. 11. Gonatocerus ovicenatus, male.
Fig. 12. Gonatocerus ovicenatus, female.

THE POISONOUS EFFECTS OF THE ROSE CHAFER UPON CHICKENS

By G. H. LAMSON, JR., *Storrs, Conn.*

Serious losses have occurred each year during June and early July, from chickens having eaten the rose chafers (*Macrodactylus subspinosus*). These losses have often been ascribed to various causes but close observations have shown that the chickens are very fond of eating the insects and post mortem examinations have revealed the presence of many undigested rose chafers in their crops. The crops are usually so full as to give the impression that death had been due to a "crop-bound" condition of the chickens. Some have also supposed that these deaths were due to a mechanical injury of the crop by the spines on the legs of the insects having punctured the lining of this part of the digestive system while others have accounted for the death of these chickens by the rose chafers having bitten the crops.

A number of cases, some of which resulted in the loss of several hundred chickens, were reported to the writer and experiments in feeding rose chafers to chickens were taken up at the Storrs Agricultural Experiment Station in 1909.

The deaths from this diet usually occurred in from nine to twenty-four hours after feeding. This led the writer to believe that undoubtedly death resulted from a cause other than a mechanical injury to the crop or "crop-bound" condition. An extract was made from crushed rose chafers and distilled water, filtered, and fed to chickens in varying doses with a medicine dropper and this resulted in a great many deaths. Small chickens died in a few hours after feeding, older chickens of heavier weight, when fed a small quantity of the extract, lived but showed signs of poisoning; large doses resulted in their deaths. Mature hens did not die from the poison.

From 150 to 200 chickens have been fed either with the rose chafers

or with varying strengths of the extract to determine the weight of the chicken killed by a certain amount of poison, also to determine the age limit of the chickens killed.

The results may be summarized as follows: 15 to 20 rose chafers are sufficient to cause the death of a chicken a week old. From 25 to 45 rose chafers are usually necessary to kill a three-weeks-old chicken. While some nine-weeks-old chickens have been killed by eating rose chafers, only one ten-weeks-old chicken was killed in these experiments. In the crop of this chicken there were 96 undigested rose chafers counted in post mortem examination.

The chickens feed upon the insects ravenously, being attracted by their sprawly appearance and usually within an hour after eating they begin to assume a dosing attitude, later leg weakness shows and the chicken usually dies within 24 hours of having eaten upon these insects, or begins to improve after this time.

In less than five per cent. of the deaths convulsions occurred. Post mortem examinations showed no abnormal condition of the organs. In order to exclude the possibility of arsenical poisoning due to the rose chafers having probably fed upon leaves that had been sprayed, tests were made by a chemist for arsenic, but no evidence of arsenic was found. Intravenous injections also were made in these experiments, extracts for injection being made from forty grams of rose chafer and sixty grams (cc.) of a salt solution having a specific gravity of .9 per cent. This extract was put in a centrifuge for five minutes, the extract drawn off in a pipette and filtered in vacuo.

Three cc. of this extract was injected into a 690 gram rabbit intravenously and this died in six minutes. Another rabbit, weighing 1,435 grams, died after an injection of four cc. of this extract in three and one-quarter minutes. A small 610 gram rabbit, when injected with two and one-half cc., died in fifty-five seconds after injection, and a large 1,450 gram rabbit died in two hours and thirty-five minutes after being injected with two cc. Other rabbits were injected and killed by this extract but further work needs to be done to determine what is a lethal dose for rabbits and also experiments in feeding rabbits per os will be taken up next summer.

As near as the writer can determine, the rose chafers contain a neuro toxin, that has a direct effect upon the heart action of both chickens and rabbits and is excessively dangerous as a food for chickens.

Owing to the fact that the insect feeds upon such a large number of plants it seems essential that chickens be kept in mowed fields and away from yards having grape vines and any flowering shrubs during the month when rose chafers are most numerous, especially during years when rose chafers are particularly abundant.

Scientific Notes

Cyllene robiniæ and Crioceris in Colorado. I regret to have to record the appearance in Boulder, Colo., of two pests which I have not observed before, and which have presumably been very recently introduced. Three times, during September and October of this year, I have picked up specimens of *Cyllene robiniæ* Forst., which have been crushed on the pavement by the feet of the passersby. Also this fall my wife has twice found specimens of *Crioceris asparagi* L. in the bags covering sunflower heads. They must have come from adjacent patches of asparagus.

T. D. A. Cockerell.

The Edibility of Insects. Very little has been done recently toward testing the edibility of many species of very abundant insects which theoretically must have a very positive food value, but at my suggestion Mr. J. J. Davis and Mr. D. G. Tower at La Fayette, Ind., have recently experimented to some extent with the eggs and larvæ of Lachnosterna. They find that Lachnosterna eggs crisply fried in butter are excellent, having a taste very much like a fine grade of bacon. The larvæ, fried in butter and eaten with bread in the form of a sandwich, were not at all disagreeable, having a fresh fatty taste. They ate the heads and all, and the heads were crisp and caused no inconvenience. This line of experimentation seems to me very well worth while, and field agents having the opportunity and disposition are urged to experiment in this direction when it can be done easily and without loss of time.

L. O. Howard.

An Eriococcus on Gaylussacia. Some time ago we received from Dr. E. P. Felt specimens of an *Eriococcus* on twigs of *Gaylussacia*, collected at Hammond, N. Y. The pure white female sacs are of the usual form, 2.25—2.50 mm. long. The surface rough with protruding filaments; female in sac bright red (in *E. azaleæ* it is dark purple, almost black); larvæ bright raspberry red. The following measurements in microns are from the adult female: antennal joints, (1) 43–45, (2) 23–25, (3) 35–38, (4) 28–30, (5) 13–15, (6) 13–15, (7) 28; middle leg, trochanter and femur, 115, tibia, 80, tarsus, 105, claw, 28. The caudal lobes are prominent, about 88 long, with bristles about 112. Bristles of anal ring 68 long; average dermal spines about 40. There is a denticle near apex of claw. This insect is quite distinct from those previously recorded from the Eastern States and from Europe, but we find it impracticable to separate it from the western *E. borealis* Ckll., except as a rather small variety. *E. borealis* is known from the Alaskan region down the Rocky Mountains to New Mexico and it is not surprising to find it in New York state. It feeds on several species of woody plants.

T. D. A. Cockerell and Elizabeth Robinson.

Soft Maple Leaf Midge (*Rhabdophaga aceris* Shim.). This species establishes itself in the unfolding, succulent leaves of the white or soft maple, preventing the normal expansion of the affected lobes and when there is a serious infestation, one or more lobes of the affected leaves may curl and die. The full grown larvæ are stout, yellowish-white or yellowish-orange, especially anteriorly, and about 2 mm. long. They occur mostly on the tip of the leaf, lying along the principal or lateral veins of the lobes. The probabilities are that the midges oviposit on the unfolding leaves or at least the tips of the leaves. Infestation is presumably favored by conditions producing a rapid, succulent growth. Pupation is on the leaf, in a yellowish-brown, irregularly oval cocoon about 1.5 mm. long. The final transformations are rapid, probably being completed within 48 hours and possibly within 24 hours.

This insect has been unusually abundant in the vicinity of Albany and has caused material injury in the case of small trees. It has also been reported to us the past summer by Mr. S. B. Fracker from northwestern Iowa and as very common in southeastern Wisconsin. Watching for the earliest signs of injury to the developing leaves and prompt spraying with a contact insecticide is the most promising method of controlling the midge. E. P. Felt.

The Desirability of Host Labels for Parasites. Recently, while looking over a systematic paper prepared by one of the parasitologists of the bureau, I noted that the data concerning hosts which accompanied the description were sometimes lacking and generally insufficient. For many years I have kept a card catalog of the recorded host relations of parasitic Hymenoptera, and a duplicate of this card catalog is now in the hands of Mr. Harry S. Smith of Sacramento, who is arranging it for possible publication under our joint authorship; and this is the reason why I have especially noticed this point. When field workers send in parasites for determination, many of which will of course be new to science, it is of great importance from my point of view that host labels should accompany the specimens. Of course a biological number referring to "Webster Notes" or "Hopkins Notes" or "Bureau Notes" will eventually enable some one to find out the facts concerning the host insects, but it is perhaps too much to expect of a systematic worker that he write for these data to headquarters, or to the field men, since often field notes are not sent in for months, and it frequently happens that the systematist is desirous of publishing immediately. Further the mere name of the host is not sufficient, but the stage should also be mentioned; that is, whether the parasite issued from the egg, from the larva, or from the pupa of the host. L. O. Howard.

Gall Midges in an Orchard. Observations on a quiet, lowery morning in a Baldwin orchard at Spencerport, N. Y., July 29, 1915, revealed an interesting condition in that thousands of small midges, a species of Parallelodiplosis, were to be seen hanging from spiders webs. The webs were rather common at the base of the larger branches, in a few instances had a transverse diameter of six or seven inches, and were composed of several layers or series of webs, the latter separated from each other by a distance of half an inch or more. It was easy to find series of five or ten midges on strands of the smaller webs, the insects being about one-fourth of an inch apart, arranged in rows, swaying freely with gentle breezes, and mostly on the lee side of the trees. The tendency of the midges was to alight side by side as nearly as they could without disturbing adjacent insects, and the regular arrangement was determined by the plan of the web, the flies naturally resting upon the larger, stouter threads. It was not uncommon to find hundreds, and in a few cases six or eight hundred of these midges upon the larger webs, and in the case of the latter they might be four or five deep, due to the several layers of the web offering attractive resting places. The small flies were timid and easily disturbed, though with care it was possible to approach within two or three feet without alarming many of the insects. On being disturbed, the midges would swarm about their haunts for a brief time and then slowly return in much the same way as commonly observed among flocks of birds. There was no evidence to show that the spider architects preyed to any considerable extent upon the midges, though the latter were far more abundant than any other form of life. A few midges were observed resting upon the trunk, especially clinging to fragments of webs, though retreats of this character were distinctly less favored by the insects.

This appears to be a fairly common habit among the smaller gall midges, at least, and similar observations in regard to several species and genera have already been put on record. E. P. Felt.

Another Nodule-Destroying Beetle. Records of insect larvæ which destroy the root nodules of legumes are apparently scarce. In addition to the Chrysomelid, *Cerotoma trifurcata* (pp. 261–266), it seems worth while to record an Otiorhynchid, *Eudiagogus rosenschoeldi* Fahrs. Late in August, 1913, the writer found that the nodules on the roots of *Sesbania macrocarpa* growing at Greenwood, Miss., were injured, but the insect which caused the damage was not present. The injury to the nodules was characteristically different from that caused by *Cerotoma*, and in view of the fact that adults of *Eudiagogus rosenschoeldi* had been previously observed feeding on the foliage of this plant, it seemed strongly probable that the larvæ of this beetle were responsible. During the following year Mr. C. F. Turner of the Bureau of Entomology found the larvæ responsible for this injury. He reared the adults and they proved to be the species suspected.

The nodules on the roots of this plant are very numerous and almost spherical. The larvæ are much more robust than those of *Cerotoma*, and they gnaw into one side of a nodule and out on the opposite side. All that is left of the nodule is a convex ring of epidermal tissue. When these injured nodules were first observed, practically all on the plants had been destroyed in this way. The larvæ probably feed on the roots as well.

Adults of this beetle have been taken during the winter hibernating in clumps of *Andropogon virginicus* and between the husks and under the leaf sheaths of standing corn stalks. The host plant does not appear above ground until May and adults have not been observed between the last of June and the middle of August. Adults were taken August 15 at Clarksdale, Miss.; August 23, at Elizabeth, Miss.; August 28, at Hardee, Miss., where they were found in copulo, and at West Memphis, Ark., September 23. There is probably but one generation a year in this region.

The beetle has been recorded as feeding on *Cassia occidentalis*, *C. obtusifolia*, *Sesbania vesicaria*, and on *Xanthoxylum clavaherculis* (see Pierce, W. D., "On the Biologies of the Rhynchophora of North America," University of Nebraska, 1907, pp. 256–257, and Mitchell, J. D., and Pierce, W. D., "The Weevils of Victoria County, Texas," Proc. Ent. Soc. Wash., Vol. 13, 1911, p. 50). Its principal hosts are thus seen to be legumes. While it is not known to damage cultivated species, the fact that it does defoliate *Xanthoxylum* would indicate that it is capable of varying its food plants. With the draining of the swamps and the decrease in its native hosts, it may some time become a pest, especially upon some of the introduced forage plants.

W. R. McConnell,
Bureau of Entomology.

Notes on Some Unusual Nursery Insects. *Pseudococcus kraunhiæ*[1] Kuwana (Homop.). This mealy bug was found during July, 1915, at Rutherford, N. J., on *Taxus cuspidata brevifolia* growing in a nursery. It had evidently been established for several years and only recently became abundant enough to cause noticeable injury. Mrs. Fernald, in her catalog of the "Coccidæ of the World," gives its habitat as Japan and host plant as *Kraunhia floribunda*. Some of the infested plants at Rutherford originally came from Japan.

Antonina crawi[1] Ckll. (Homop.). This insect, known as the cottony bamboo scale, was taken in considerable numbers at Riverton, N. J., August 6, 1915, on *Bambusa henonis* and *Bambusa aurea*, to which it was doing considerable damage by collecting in large colonies in the leaf axils of the young shoots or canes. This also is a Japanese species which occurs in California.

[1] Identified by Mr. Rust of the U. S. Bur. Ent.

Trioza magnoliæ Ashm. (Homop.). These "jumping plant lice" were exceptionally abundant on bay trees at Rutherford, N. J., during July, resulting in a deformation of almost every leaf on the trees. Tobacco extract and whale oil soap was found effective in controlling them.

Pteronus hudsonii Dyar (Hymen.). Larvæ of this saw-fly were found for the first time in New Jersey feeding on *Populus canadensis* at Rutherford and Trenton during the middle of August, 1915. The larvæ feed on the edges of the leaves and when disturbed thrash their abdomens about more or less violently.

Otiorhynchus sulcatus Fab. (Coleop.). This weevil, which is listed in Insects of New Jersey as occurring in different parts of the state, has recently become somewhat of a pest on rhododendrons and Taxus in several large nurseries. Dr. A. D. Hopkins gives the following interesting information about this species.

"*Otiorhynchus sulcatus* is a European species which has been established in this country a considerable number of years. In central Europe it is known according to Sorauer, to feed on grape vines, ground berries, peaches, flowers with juicy roots or root stalks, ferns and particularly Taxus and rhododendrons. It occurs there in light sandy or clay soils, in desert lands, meadows, forests, etc.; also in hothouses and manure piles. It seriously injures grapes by eating the leaves and buds in the spring. The principal damage is by the larvæ which seriously affect or even kill the stems. Their development is very uneven; normally the mature larva hibernates and pupates in the spring but also young larvæ from eggs laid late in the season hibernate and feed in the spring until pupation; some of the beetles issuing from the latter may again hibernate so that the same individual may hibernate twice. In general their seasonal history in this country is very similar to that of *O. ovatus*. Adults emerge from the soil during May, June and July and oviposit during June–August. The eggs are laid in the ground and the larvæ which hatch about two weeks later feed on the roots of their favorite plants. After hibernation they resume feeding in the spring and pupate in the soil during April and May. Trapping the adults by means of bundles of moss, leaves, straw, etc., placed on the ground in the evening and burned in the morning, is the most effective control method in Europe and likewise here. Advantage may also be taken of their habit to congregate in hiding during the day under boards and similar places." Dr. Hopkins advocates a thorough trial with tobacco dust for combating them after they are once in the ground. No determined effort has ever been made by New Jersey nurserymen to control this pest, it being considerably cheaper to sell the insects along with the plants.

HARRY B. WEISS, *New Brunswick, N. J.*

Sedentary Aphids vs. Spread of Fire Blight. In a recent number of *Phytopathology* I have tried to show that aphids are among the chief carriers of fire blight. An experiment seemed necessary at the time these tests were made to investigate the published statements that aphids are sedentary in habits while the Heteroptera so far studied on apple are not. If aphids are extremely sedentary, they can not rank as chief carriers. Let us see.

First, prolonged study showed that the six or seven different species of aphids, now reported on apple, are far from synchronous in their May to midsummer migrations. There is thus a nearly continual shifting of the aphis population, independent of enemies, interrupted only by each cooler weather period. Fire blight is likewise checked during the cooler periods of the growing season, but during optimum temperatures may be opportunely spread by aphids and leaf hoppers of one or the other shifting species.

Second, aphids are shown not to be sedentary with reference to a single shoot. An infested sprig of blighting crab was placed in a bottle of water in the laboratory.

The aphids slowly retreated downward to the cotton plug in the neck of the bottle where those which did not transform into winged aphids died, presumably from starvation. Under orchard conditions, such aphids should, in the light of the series of tests reported in *Phytopathology*, scatter blight to other shoots. It has since been observed in nature by Jones[1] who watched a colony of *A. pomi* vacate a blighting shoot, each individual descending to the base and going up fresh twigs. In thus scattering, they carried infection to seven surrounding clean shoots which blighted within a few days following their attacks. This may help explain the continued activity of blight in many trees where thorough pruning has been resorted to, and supports the view that aphids are among the chief carriers.

Third, intensive study of fertile stem mothers and later fall-bearing females shows that some mothers drop all their young in a very circumscribed area, on a given leaf or shoot, while others wander considerably before they are all through bearing young. Neither method of grouping young can be called unique for any particular species. Furthermore, injury to a young twig such as when blight attacks it, would produce some migration as shown by the above experiments. Under such conditions is it very important to consider the aphids as particularly sedentary?

Further observations on the habits of these aphids and other common Homoptera ought to be made before we may decide definitely which type of insect is most serious in the distribution of the germs of fire blight, after bees have stopped working in the blossoms.

A. C. Burrill,
Department of Economic Entomology, University of Wisconsin.

English Sparrows and Spread of San José Scale.[2] The English sparrow has been considered, with other wild birds, as carrier of the pernicious scale, but I am not aware that any very thorough study of the relative value of different birds as carriers has been made.

The following note compiled from a survey for the extermination of scale in Wingra Park, an isolated suburb of Madison, Wis., is a statistical attempt to produce further proof against the sparrow. The district surveyed was bounded on the south by a lake, on the east by a vacant marsh, on the north by a railroad cut and open lots, and on the west by farm fields, so that we may safely say that there was no possibility for the presence of scale within two or three city blocks of the surveyed infested area. In this circumscribed area we may suppose the English sparrow to be the only undomesticated bird species which would normally restrict its flight to so small an area, and serve as local carrier for short distances, since comparative psychologists consider the English sparrow very local in its habits of flight.

The area contained sixty-four infested city lots. In these lots all infested woody plants were either within one hundred feet of each other, or within one hundred feet of some place where English sparrows regularly came to feed. Places counted as English sparrow feeding centers were barns occupied by horses where grain feed was regularly exposed in manure piles, and chicken coops, where garbage and grain were regularly exposed.

The apparent relation between these feeding places and nearby woody plants is revealed by a study of the bird's habits. It is the habit of these birds, when coming towards feeding places, to fly into the branches of a woody plant to see that the

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[1] Jones, B. J. The natural modes of distribution of fire blight. Mo. Bul. State Com. Hort. Cal., 3, 12:505–11, 1914.

[2] Published with the permission of Prof. J. G. Sanders, Department of Economic Entomology, University of Wisconsin.

coast is clear, before descending to the ground to feed. In the same way, when they are suddenly disturbed, they fly back to an adjacent woody plant before going off, or returning to feed. Upon correlating this habit with the majority of infested plants I found that the infestations were not as near the main streets as they were to the alleys back of the lots, and that the feeding places—all barns, chicken coops and garbage—were invariably next the alleys.

The fact that these same feeding places are most often visited by human occupants of the land may be said to somewhat invalidate the theory that the sparrow is chief carrier. In rebuttal note that woody plants in the front yards and near the going and coming of the occcupants of the houses were less often infested. Thus human carriers and their most frequented routes did not usually coincide with the local infestation. This argues for considering birds and not men as the chief cause of infestation in the Wingra Park residence district of Madison.

Further details support the general conclusion. Of the several hundred city lots in Wingra Park, the tally of feeding places is as follows: three spots where garbage is openly scattered, but where chickens are not fed; forty-seven chicken coops and twenty-eight barns sheltering horses. The exact number within the general area of sixty-four infested lots is thirty chicken coops, and twenty-three barns, and all but three of these coops and one of the barns failed to have scale infestations within one hundred feet of them. Thus, about 90 per cent of the coops and barns within the infested area had scale located on nearby trees and shrubs, and about 85 per cent of the infested lots had sparrow feeding places on or next to them.

In some large trees only upper branches were infested, undoubtedly caused by perching birds. Sparrows regularly perch to bask in the sun when not feeding. Many of the infested trees and shrubs were in sunny, sheltered spots where sparrows regularly perch. The fact that twenty-two similar feeding points outside the exact infested area failed to show scale may be attributed to the hazards of chance and to the fact that sparrows fly short distances at any one time. Thus, if scale were on the birds when they retired to their nests, the scales would probably perish over night in hiding on the bird, in crawling off the bird and in wandering about the nest and eaves. No sparrow nests were noted in the trees, still further reducing the chances of scales to locate on host plants.

No native wild bird appears to have the exact feeding habits of the English sparrow, and, therefore, does not seem to fit the actual conditions of infestation as found. I should be glad to hear from other inspectors and entomologists if they differ from the way in which I have tried to apply the actual facts to the theory that English sparrows are chief carriers of scale in a closely settled residence district.

A. C. Burrill,
Department of Economic Entomology, University of Wisconsin.

JOURNAL OF ECONOMIC ENTOMOLOGY

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The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engraving, may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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The convincing or popular value of figures is well brought out in the article on estimating the number of grasshoppers. The man on the street has a liking for definite figures and the man on the farm is very like him in this respect. The successful entomologist must be enough of a psychologist to correctly estimate the value of various methods of presentation and it would seem that in some cases, at least, figures might be used a little more freely with great advantage. We do not mean by this, the more general employment of tables for the presentation of scientific data, useful though they may be, but the translation of familiar and vaguely appreciated infestations, for example, into definite, easily grasped mathematical equivalents. It would be even better, as suggested by this writer, if the hordes of insects could be valued in terms of produce necessary to their development.

It will be noted elsewhere in this issue that an entomologist holding an important position and apparently giving excellent satisfaction, has not been reappointed by a state executive. Knowing nothing of the details of the situation, we can only call attention to the well-known fact that uncertainty of tenure of office means a lowered efficiency in scientific work and especially is that true of a science dealing with such immense numbers of forms as are found among insects and which respond in so diverse ways to climatic and other influences. It should require little argument to demonstrate that a man with six years' experience in such a responsible position and meeting successfully its many and varied requirements would of necessity, in addition to prerequisite knowledge, possess a vast fund of practical experience of immeasurable value to the state which has profited by his services. If this is a removal on political grounds, then, we believe, the state has been unfortunate in the selection of its chief executive, and the continuance of such a policy means irreparable loss to the material interests of its citizens.

Current Notes

Conducted by the Associate Editor

Mr. C. A. Good has been appointed assistant entomologist at the Nova Scotia Agricultural College.

J. H. Fabre, the French entomologist, and the author of a number of popular books about insects, died October 11.

Messrs. Leroy Childs and G. F. Moznette have severed their connection with the Oregon Station, where they held positions as research assistants in entomology.

Mr. C. L. Scott, Bureau of Entomology, has been transferred from the Brownsville (Tex.) station to Wellington, Kan.

Mr. F. L. McDonough, Bureau of Entomology, was occupied during October in determining the limits of the dispersion of the boll weevil.

Dr. E. A. Back, Bureau of Entomology, in field charge of the Mediterranean fruit-fly investigations in Hawaii, has returned to Honolulu.

Mr. W. H. Larrimer, Bureau of Entomology, formerly located at the Wellington (Kan.) field station, has been detached and stationed temporarily at Missoula, Mont.

Mr. E. R. Barber, Bureau of Entomology, has returned to New Orleans after an extensive trip to determine the extent of the territory infested by the Argentine ant.

Mr. Harold Lyon, a graduate of the Massachusetts Agricultural College, class of 1913, is now studying at the Bussey Institution, Harvard University, Forest Hills, Mass.

Dr. E. A. Back, Bureau of Entomology, in charge of Mediterranean fruit-fly investigations in Hawaii, visited Washington on August 19 for consultation with reference to future work.

Professor H. F. Wilson of Oregon State College, has gone to the University of Wisconsin as professor of economic entomology to take the place of Professor J. G. Sanders.

Mr. R. J. Fiske, a graduate of the Massachusetts Agricultural College, class of 1910, is now engaged in codling moth investigations for the Bureau of Entomology at Roswell, N. M.

Mr. W. T. M. Forbes, a specialist in Lepidoptera, has been appointed to a position on the staff of the entomological department of the College of Agriculture of Cornell University.

Professor E. D. Sanderson is now a graduate student at the University of Chicago, where he expects to remain for two years or perhaps longer. His present address is 1109 East 54th Place.

Mr. J. R. Christie, formerly a student at the New Hampshire Agricultural College, is now instructor in zoölogy and entomology at the Maryland Agricultural College and assistant entomologist in the Station.

Mr. F. C. Bishopp, Bureau of Entomology, during the month of August investigated a serious outbreak of horse flies in Nevada and California upon which assistance had been asked by the Nevada Experiment Station.

Mr. Wallace L. Chandler, formerly of the University of California, has recently been called to Cornell University, where he will give instruction and conduct investigations in parasitology as a member of the entomological department.

Mr. F. A. Fenton, a graduate student of the University of Wisconsin, and for a time deputy nursery inspector in the same state, has joined the Federal Bureau of Entomology and will be engaged in work with Mr. J. J. Davis at Lafayette, Ind.

Mr. Henry L. Viereck is no longer connected with the California State Commission of Horticulture, where he has recently been assistant superintendent of the insectary at Capitol Park, Sacramento.

Mr. August Busck, Bureau of Entomology, has returned to Washington from the Hawaiian Islands where he carried on an investigation of *Gelechia gossypiella* for the Federal Horticultural Board.

Mr. Eric Cogan, Bureau of Entomology, temporarily employed at the Charleston (Mo.) field laboratory, has resumed his studies at Ohio State University. Mr. Cogan is specializing in Jassidea.

Miss Myrtle Duckett has been appointed a student assistant in the Bureau of Entomology to assist in recording the results of the wintering experiments in apiculture.

Mr. R. J. Kewley, Bureau of Entomology, recently attached to the staff at the La Fayette (Ind.) station, has been detailed to assist Mr. A. B. Gahan at College Park, Md.

Mr. E. W. Scott, Bureau of Entomology, employed in connection with the enforcement of the Insecticide Act, made a trip of investigation through Georgia and Florida during late October.

Dr. A. D. Hopkins returned to his office on October 27 from Kanawha Station, W. Va., where he was on leave and continued his observations on phenological phenomena, forest and wood-boring insects.

Mr. E. J. Newcomer, Bureau of Entomology, will spend the winter months at his permanent field quarters, Wenatchee, Wash., and will give attention to questions connected with the winter life of certain orchard pests.

Mr. John B. Gill, Bureau of Entomology, engaged in pecan insect investigations, has returned to his field headquarters, Monticello, Fla., from an extended trip through the Gulf States in connection with the study of pecan insects.

Mr. H. H. Kimball, Bureau of Entomology, who has been associated with D. L. Van Dine at Mound, La., will transfer his work to New Orleans where he will assist Dr. W. V. King in rearing Anopheles mosquitoes.

The Siamese grain beetle (*Lophocateres pusillus* Klug) has been reported by Prof. E. S. Tucker, at Baton Rouge, La., injuring rice. This species is not common in this country, but has been found in Texas, South Carolina, and received from foreign countries.

Mr. E. J. Branigan, field deputy of the California State Commission of Horticulture, is temporarily located at the Pasadena Station, Bureau of Entomology, distributing *Leptomastix* sp., a parasite of the citrus mealy bug (*Pseudococcus citri*). This parasite was recently introduced from Sicily.

Professor H. A. Ballou, Entomologist on the staff of the British Imperial Department of Agriculture, for several years stationed at Barbados, West Indies, is studying during his vacation at the Massachusetts Agricultural College, from which he graduated in 1895.

Mr. Alfred B. Champlain, assistant forest entomologist of the Bureau of Entomology, is now at Lyme, Conn., where he is making observations on the hickory bark beetle and other borers, and at the same time is receiving medical treatment for an ailment of the stomach.

Mr. Edward Riley King of Creola, Ohio, a former deputy state inspector of apiaries and secretary of the Ohio Beekeepers' Association, has been appointed a member of the teaching staff of the College of Agriculture of Cornell University, where he will conduct the new courses in apiculture.

Mr. F. B. Paddock has been appointed entomologist in charge at the Texas Agricultural Experiment Station and State Entomologist to succeed Mr. Wilmon Newell who has gone to Florida as State Plant Commissioner. By virtue of law the state entomologist is in charge of the foul brood eradication work.

At the New Hampshire College, Mr. W. A. Osgood, class of 1915, has been appointed assistant to Professor W. C. O'Kane and will be engaged in state work. He began his duties September 1. Mr. Raymond Bean, class of 1915, has been appointed assistant to Professor C. F. Jackson in the department of zoölogy.

In connection with the wintering investigations at the apiary of the Bureau of Entomology, tests are now being made of the thermal conductivity of various double-walled hives and of the coefficient of transmission of heat of the various parts of the hive to determine the best methods for constructing such hives.

Mr. David L. Crawford, formerly entomologist and horticulturist for the Mexico Gulf Coast Citrus Association, Tampico, Mex., has submitted for publication, in the Department of Agriculture, a manuscript on the Mexican orange fly, *Anastrepha ludens* Loew.

The Bureau of Entomology has received from Mr. C. F. Stahl, Spreckels, Cal., a sample of walnuts badly infested by the Mediterranean flour moth, *Ephestia keuhniella*. These were obtained in October of the present year. It also occurs in peanuts in the East.

Mr. H. B. Scammell, Bureau of Entomology, will spend the winter at his field station, Brown Mills, N. J., and will give special attention to questions connected with the hibernation of cranberry insects. Mr. R. J. Fiske will also spend the winter at his field headquarters, Roswell, N. Mex.

Mr. T. C. Barber, Bureau of Entomology, delivered a number of addresses on the boll weevil in Georgia during October. This work was a part of the plan of the Georgia State Board of Entomology to give special instructions to the planters in the districts which have recently become invaded by the boll weevil.

Mr. H. A. Morgan, director of the Tennessee Experiment Station, recently visited Louisiana, in company with Dr. W. D. Hunter of the Bureau of Entomology, for the purpose of making suggestions regarding the conduct of the boll-weevil work, and the work on malaria mosquitoes.

At the Kansas College and Station, Dr. Paul S. Welch, who has been engaged in the investigation of staple crop insects for the Station, is now giving his entire time to college work as assistant professor of entomology. Mr. W. P. Hayes has been added to the station staff as assistant in entomology, and will investigate the insects attacking staple crops.

Mr. Frank N. Wallace has been appointed State Entomologist of Indiana to succeed Charles H. Baldwin. Mr. Wallace was Chief Deputy under Benjamin W. Douglass, who was State Entomologist of Indiana from 1907 to 1911. During the past four years Mr. Wallace has been engaged in horticultural consultation work and has been called to orchards in many parts of the country.

Mr. A. C. Baker, Bureau of Entomology, has reported for permanent duty in Washington and will be engaged in systematic studies of the Aphididæ and Aleyrodidæ. The biological studies of orchard plant lice in progress at the Vienna (Va.) laboratory will, however, be continued by Messrs. A. C. Baker and W. F. Turner, Mr. Turner remaining at the laboratory at Vienna.

Mr. E. G. Carr, Bureau of Entomology, spent the month of October in the mountain section of North Carolina and reports that beekeeping is not well developed there but that there is a wonderful opportunity for making it an important phase of agriculture since there is an abundance of nectar and plenty of bees to gather it if properly cared for.

Mr. R. S. Woglum, Bureau of Entomology, recently visited San Diego, Cal., for the purpose of investigating a species of *Pteliobius* injuring olive. This olive insect was found to be established in various sections of San Diego County. Breeding occurs only in the dead wood. However, the adults cause considerable injury to living trees, especially to the smaller twigs, by boring into and feeding on the bark.

Among insects which have been reported as causing injury during the year are the spotted cutworm (*Noctua c-nigrum L.*) and the variegated cutworm (*Peridroma margaritosa* Haw.). The last-mentioned species was especially numerous and was reported as occurring in Brownsville, Tex., where it was injurious to onions, and found commonly on weeds and grasses; also along the coast of California and at Norfolk, Va.

Dr. E. F. Phillips made plans to leave about November 20 to attend meetings of beekeepers in Ontario, Ohio, Chicago and Springfield, Ill., Kansas, Minnesota, Wisconsin, Indiana, Iowa and Michigan. This circuit of meetings was arranged to make it easier for those interested to attend. The meeting at Grand Rapids, Mich., is the fiftieth convention of the Michigan society and elaborate preparations are being made for it.

Among the visitors at the Bureau of Entomology during October were the following: C. P. Lounsbury, chief of the Division of Entomology of the Union Department of Agriculture, South Africa; H. A. Ballou, entomologist on the staff of the Imperial Department of Agriculture for the West Indies; C. W. Leng, New York; W. T. Davis, Brooklyn; W. S. Blatchley, Indianapolis; J. v. d. H. Schreuder, Pretoria, South Africa.

Mr. F. R. Cole reports to the Bureau of Entomology that the tachinid parasite, *Siphona plusiæ* Coq., has been reared from the cabbage looper (*Autographa brassicæ*) from Whittier, Pasadena and Compton, Cal., the last locality being furnished by Mr. J. E. Graf. This species was described from *Autographa californica* Speyer from Southern California. Another parasite attacks this species but it has not been reared or identified as yet.

Dr. Alden T. Speare has recently been appointed a specialist in insect diseases in the Bureau of Entomology and will make a thorough study of entomogenous fungi, with a view to their practical utilization if possible in insect control. He will be glad to receive specimens of diseased insects from all sources, and the material should be accompanied with full data as to the host-species, extent of outbreak of the disease, locality, etc.

According to press reports, Professor Gordon M. Bentley, State Entomologist of Tennessee, has not been reappointed. The following excerpt is from *The Southern Florist* for October: "Despite the petitions and urgent requests of fruit growers,

nurserymen, farmers and business men generally Governor Rye, through the new commissioner of agriculture, refused to reappoint Prof. Gordon M. Bentley to the important position of state entomologist of Tennessee."

The office of State Entomologist has recently been established in Wisconsin, to take over the nursery and orchard inspection and administration of the laws governing insecticides and fungicides. It is to be independent of the University of Wisconsin, with headquarters in the State Capitol at Madison. Professor J. G. Sanders comes from the College of Agriculture to be the first incumbent of the office and Dr. S. B. Fracker, an instructor in the same department, has been appointed assistant entomologist.

The spinach leaf-miner (*Pegomyia vicina* Lintn.) has been reported as injuring garden beets during June and July at Green Bay, Wis., by Mr. N. F. Howard, working temporarily for the Bureau of Entomology. It has also been reported injuring spinach at Woods Holl, Mass., the correspondent stating that after the spinach was boiled the little white maggots could be seen on the surface. It may be remembered that those who have tried kerosene emulsion for the insect as it occurs in the mines have obtained no results.

Some interesting species of insects injurious to stored products have recently been collected. One is the broadheaded flour beetle (*Latheticus oryzæ* Waterh.), reported by Mr. F. B. Milliken in two mills at Wichita, Kans. The files of the Bureau of Entomology show that this species was also reported at Wichita Falls, Tex., in 1909, and at Lyons, Kans., in July, 1908. It is common in Texas, and has only in recent years spread widely to other regions; for example, to Baton Rouge, La., Elizabethtown, Ill., and Detroit, Mich.

The semitropical army worm (*Prodenia eridania* Cram.) has been reported, with accompanying specimens, as being injurious at Hastings, Fla. This army worm appeared in a field of cowpeas, traveled to a field of sweet potatoes, and crossed a ditch by means of overhanging weeds into another field of cowpeas and corn. It was impossible to spray the cowpeas and corn, but the correspondent stated that he could save the sweet potatoes by other treatment. Several other reports have been made of an insect which is probably this species, though it has not been positively identified.

Mr. T. E. Snyder, Bureau of Entomology, left on October 23 for a ten-day trip to Savannah, Ga., Virginia and Tennessee. At Savannah he inspected treated telephone poles for resistance to insect attack. This work is being done in coöperation with the American Telegraph and Telephone Company. In the latter states he inspected the control work against the southern pine beetle by the Forest Service in the White Top Purchase Area and to mark newly infested trees for further control work.

The fifty-second annual meeting of the Entomological Society of Ontario was held at Ottawa, November 4 and 5 under the presidency of Dr. C. Gordon Hewitt, the Government Entomologist. The program was varied and most interesting, and the meeting was very successful, a goodly number being in attendance. Dr. H. T. Fernald gave an illustrated lecture on: "Life Zones in Entomology and their Relation to Crops." There were a number of economic papers, one of the more interesting dealing with the extraordinary outbreak of *Lygus invitus* by W. Brittain. A full account of this meeting will appear in the annual report of the Society, a publication well and favorably known to American entomologists.

Dr. E. F. Phillips, Bureau of Entomology, attended a meeting of the farm demonstrators of North Carolina at Raleigh on August 21 and 23 for the purpose of arranging for a new line of work soon to be undertaken. It is planned to make a survey of the state for the purpose of determining the possibilities of building up beekeeping and to test out, in coöperation with the county agents, various lines of extension work. E. G. Carr, deputy state apiary inspector for New Jersey and a director of the National Beekeepers' Association, has been appointed to do the field work on this project and will begin work on October 1. Mr. Carr has had extensive experience as a practical beekeeper and has served as inspector for several years.

Mr. J. R. Horton, Bureau of Entomology, in field charge of the citrus fruit insect investigations in Louisiana, recently submitted an account of the hurricane which passed through southern Louisiana on September 29. He reports that in an experimental orchard at Venice fully 95 per cent of the oranges were blown off the trees, many of them being carried considerable distance. Orange trees were literally whipped to pieces and the foliage discolored, as though scorched by fire. Practically all of the ant traps and fumigation covers at Happy Jack were destroyed. Many lights were broken out of the laboratory windows in New Orleans, and one chimney was blown down. A large percentage of the cages used in fig-borer experiments were blown over, and many of the specimens disappeared. Mr. Horton left New Orleans on September 28, and was at a point near Doullutt's Canal, which was in the worst section of the storm.

Recently two new wire cages have been added to the Eastern Field Station of the Bureau of Entomology at East Falls Church, Va. Both of these consist of a temporary framework with a concrete foundation and covered with a lattice roof and completely screened in with 14-mesh galvanized screen wire. One of these is to be used for experiments dealing with insects injurious to crude forest products and the study of the life history of various secondary insects. The other one is to be used for life-history studies of the introduced *Evetria buoliana* and *Diprion simile*. In constructing this cage great care has been used. It is to be double-walled and to have a vestibule entrance. Every possible precaution has been taken in building this cage because of the danger of liberating specimens of these injurious forest insects. In this cage it is planned to grow various species of pines which may serve as hosts of the two imported species. The experiments are to be conducted entirely on growing trees and under conditions which very closely approximate those found in nurseries and forests.

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Second Annual Meeting, Champaign, Ill., Nov. 11–13, 1890. (The same officers had charge of this meeting.)

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Eighth Annual Meeting, Buffalo, N. Y., Aug. 21–22, 1896. President, C. H. Fernald; First Vice-President, F. M. Webster; Second Vice-President, Herbert Osborn; Secretary, C. L. Marlatt.

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Tenth Annual Meeting, Boston, Mass., Aug. 19–20, 1898. President, Herbert Osborn; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, C. L. Marlatt.

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Twelfth Annual Meeting, New York, N. Y., June 22–23, 1900. President, Lawrence Bruner; First Vice-President, C. P. Gillette; Second Vice-President, E. H. Forbush; Secretary, A. H. Kirkland.

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AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

(Organized 1899, Incorporated December 29, 1913)

CONSTITUTION

Article I

Name and Objects

Section 1. This association shall be known as the American Association of Economic Entomologists.

Section 2. Its object shall be: (1) To discuss new discoveries, to exchange experiences, and to carefully consider the best methods of work in economic entomology; (2) to give opportunity to individual workers of announcing proposed investigations so as to bring out suggestions and avoid unnecessary duplication of work; (3) to suggest when possible, certain lines of investigation upon subjects of general interest; (4) to promote the study and advance the science of entomology; (5) to publish the Journal of Economic Entomology.

Article II

Membership

Section 1. All economic entomologists, horticultural or apiary inspectors, employed by the General or State governments or by the State experiment stations, or by any agricultural or horticultural association, and all teachers of economic entomology in educational institutions and other persons engaged in practical work in economic entomology, may become members.

Section 2. The classes of membership shall be active, associate, and foreign. Active membership shall be conferred only on persons who have been trained in entomological work and whose practical experience or published papers have evidenced their ability to conduct original investigations in economic entomology.

Section 3. Associate membership may be conferred on persons who have done general or practical work in entomology and who have by published papers or otherwise, given evidence of their attainments in such work.

Section 4. Foreign membership shall be honorary and shall apply only to members residing outside of the United States and Canada.

Section 5. Associate and foreign members shall not be entitled to hold office or to vote.

Section 6. Membership, other than foreign membership, may be conferred at any regular meeting by a two-thirds vote of the members present upon recommendation of the committee on membership, after a regular application endorsed by two active members has been filed with the Secretary.

Section 7. Foreign members may be proposed in writing by any active member and their names shall be acted upon by the committee on membership and the Association, as in the case of other members.

Article III

Officers

Section 1. The officers shall consist of a president, one vice-president, and an additional vice-president for each section, who shall be elected annually, and a secre-

tary who shall be elected for a term of three years, who shall perform the duties customarily incumbent upon their respective offices and as defined in the by-laws. The above officers shall act as the Board of Directors and shall pass on any urgent matters that cannot be deferred until the annual meeting. The president shall not hold office for two consecutive terms.

Article IV

Annual Meeting—Quorum

Section 1. The annual meeting shall be held at such time and place as may be decided upon by the association at the previous annual meeting and special meetings may be called by order of the Board of Directors. Twenty members shall constitute a quorum for the transaction of business.

Article V

Amendments

Section 1. All proposed alterations or amendments to this constitution shall be referred to a committee of three at any regular meeting, and after a report from such committee, may be adopted by a two-thirds vote of the members present; Provided, That a written notice of the proposed amendment has been sent to every active member of the association at least one month prior to the date of action.

BY-LAWS

Article I

Of Members

Section 1. The classes of members are defined in the constitution as are their rights to vote or hold office. Members of all kinds have equal privileges as to presentation of papers and in scientific discussions at the regular meetings, and may, by permission of the presiding officer, speak on business questions before the association.

Section 2. All members in good standing have equal rights to the publications of the association or to any publications controlled or distributed by the association.

Article II

Of Officers and Their Duties

Section 1. It shall be the duty of the president, in addition to the ordinary duties of the presiding officer, to prepare an address, to be delivered at the annual meeting over which he presides. He shall also appoint the necessary committees at the first session of the annual meeting.

Section 2. It shall be the duty of the secretary to make the necessary arrangements for the meetings of the association and keep a record of the proceedings for publication, to provide the necessary stationery and attend to the general correspondence. He shall collect moneys due, pay all bills incurred by the association, submit a report at each annual meeting, and perform such other duties as may be delegated to him.

Section 3. All officers and standing committees unless otherwise provided for shall be elected by ballot after recommendations have been made by a nominating committee.

Article III

Dues

Section 1. The annual dues of active members shall be one dollar and fifty cents, and the dues of associate members one dollar, which shall be payable in advance. No dues shall be payable from foreign members. Annual dues shall not include subscription to the Journal of Economic Entomology.

Article IV

Of Meetings

Section 1. Notice of the time and place of meetings shall be sent for publication to all American entomological periodicals. The proceedings shall be published as decided by the association.

Section 2. Special meetings shall be called as provided for in the constitution, and notice of such meeting shall be given by the Secretary by mailing to each active member a formal notification of the time and place of the meetings at least two weeks before the date fixed in the notice. The notice shall state the reason for such meeting, and shall specify the business to be transacted, and no other business shall be transacted.

Section 3. The order of business at regular meetings shall be, at the first session:

1. Calling the meeting to order by the president.
2. Reports of officers.
3. Reports of committees.
4. Appointments of temporary committees.
5. Written business communications.
6. Verbal business communications.
7. New business.
8. Annual address of the president.
9. Program of papers and discussions.
10. Adjournment.

At the following session:

1. Discussion of the president's address.
2. Program of papers and discussions.

At the following sessions:

1. Program of papers and discussions.

   Business can only be introduced at these sessions by vote of the association.

At the last regular session:

1. Program of papers and discussions.
2. Reports of appointed committees.
3. Miscellaneous business.
4. Election of officers.
5. Fixing time and place of next meeting.
6. Adjournment.

Article V

Amendments to By-Laws

Section 1. Changes in these by-laws may be made by a two-thirds vote at any regular meeting; Provided, notice in writing of the proposed amendment be sent to every active member at least two weeks before the date of the meeting, at which time it can come up for consideration.

The following amendment to the Constitution is suggested to complete the directions for procedure and is published herewith because of its greater accessibility. Add a new section to Article II, as follows:

SECTION 4. The publication of the Journal of Economic Entomology shall be entrusted to an Editor, an Associate Editor and a Business Manager nominated by an Advisory Committee of six members, which latter shall be elected for terms of three years so arranged that two shall be elected annually. The members of this committee shall have an advisory relation to the above constituted Editorial Board.

TWENTY-EIGHTH ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Columbus, Ohio, December 27 to 30, 1915

The twenty-eighth annual meeting of the American Association of Economic Entomologists will be held at the Ohio State University, Columbus, Ohio, beginning December 27 and ending December 30, 1915. The meetings will be held in Botany and Zoölogy Hall in that institution.

The opening session will begin at 1.30 p. m., Monday, December 27. The annual reports and reports of committees will be presented then and the address of the president delivered. The meeting of the general association will be continued on Tuesday, at 10.00 a. m., 1.30 p. m. and on Wednesday at 1.30 p. m. The final session will be held on Thursday at 10.00 a. m.

Sectional Meetings

The meeting of the section on Apiary Inspection will be held at 8.00 p. m. Monday, December 27, at which time the regular business of the section will be transacted and a program of papers presented. The meeting of the section on Horticultural Inspection will be held Tuesday at 8.00 p. m. and Wednesday at 10.00 a. m.

Other Meetings

The American Association for the Advancement of Science and its affiliated societies will hold meetings throughout the week. The meeting of the Entomological Society of America will begin on Wednesday, December 29, and continue on Thursday and possibly on Friday. The public lecture before that society will be delivered on Wednesday evening, December 29, by Dr. C. Gordon Hewitt, Entomologist of the Dominion of Canada. A meeting of the instructors and investigators in apiculture will be held on Tuesday morning, December 28.

Smoker

The entomologists of Ohio will tender all visiting entomologists a smoker which will be held on Wednesday evening immediately after the public address.

Hotel Headquarters

The hotel headquarters of this Association has been selected at the Southern Hotel, South High Street, from which cars run direct to the Union Station and to the university. The rates for rooms, European plan, are as follows: single rooms, without bath, $1.50 per day; double rooms, without bath, $2.50 and up per day; single rooms, with bath, $2.00 per day; double rooms with bath, $3.50 and up per day. As there will be a large attendance at the meeting, rooms should be engaged well in advance.

Railroad Rates

The exact data on railroad rates are not available. Members should consult their local ticket agents or agents in the nearest large cities where reductions in rates are likely to apply. Information can undoubtedly be secured from the regular announcement of the meeting of the American Association for the Advancement of Science.

Official Buttons

Official buttons of the Association will be furnished to members whose dues for 1916 are paid. Application for buttons should be made to the Secretary at the time of the meeting.

Membership

Application blanks for membership may be secured from the Secretary or from members of the committee on membership.

Program

Monday, December 27, 1915, 1.30 p. m.

Report of the Secretary.

Report of executive committee, by President Glenn W. Herrick.

Report of employment bureau, by W. E. Hinds, Auburn, Ala.

Report of committee on nomenclature, by Herbert Osborn, Columbus, Ohio.

Report of committee on entomological investigations, by W. E. Hinds, Auburn, Ala.

Report of committee on bibliography of economic entomology by E. P. Felt, Albany, N. Y.

Appointment of committees.

Miscellaneous business.

Action on the following proposed amendment to the constitution;

Section I, Article III, insert the words "branch or" before the word "section" in line two so that the first sentence of Section I will read as follows: "The officers shall consist of a president, one vice-president and an additional vice-president for each branch or section who shall be elected annually, and a secretary who shall be elected for a term of three years, who shall perform the duties customarily incumbent upon their respective offices and as defined in the by-laws."

Action on the following proposed amendment to the by-laws:

Add a new section to Article II as follows: "Section IV. The publication of the Journal of Economic Entomology shall be entrusted to an editor, an associate editor and a business manager nominated by an advisory committee of six members which latter shall be elected for terms of three years so arranged that two shall be elected annually. The members of this committee shall have an advisory relation to the above constituted editorial board."

New business.

Annual address of the President, Glenn W. Herrick, Ithaca, N. Y., "The Need of a Broad, Liberal Training for the Economic Entomologist."

Reading of Papers

"Further Notes on *Diprion simile* Hartig," by W. E. Britton, New Haven, Conn. (5 minutes.)

Notes on the distribution, injury, number of generations and parasites of this European sawfly in Connecticut.

"A Preliminary Report on the Life Economy of *Solenopsis molesta* Say," by J. W. McColloch, Manhattan, Kans. (12 minutes.)

This paper will present the data thus far obtained on the life history of the kafir ant.

"Some Insects of *Solanum carolinense* L., and their Economic Relations," by M. P. Somes, Mountain Grove, Mo. (10 minutes.)

A review of life history of certain insects found on this weed and their development when transferred to related economic plants.

"Concerning Problems in Aphid Ecology," by Edith M. Patch, Orono, Me. (15 minutes.)

An outline indicating certain phases of aphid study with especial reference to life cycle work with migratory species.

"Life History Notes on *Apeteticus cynicus* and *maculiventris*," by R. D. Whitmarsh, Wooster, Ohio. (3 minutes.)

"Distribution of Periodical Cicada in Ohio for the years 1906, 1914 and 1915," by H. A. Gossard, Wooster, Ohio. (5 minutes.) Lantern.

Maps of the areas in which they appeared and remarks thereon.

"Honey as a Carrier of Pear Blight Germs," by H. A. Gossard, Wooster, Ohio. (10 minutes.) Lantern.

Adjournment.

SECTION OF APIARY INSPECTION

E. F. Phillips, *Chairman.* N. E. Shaw, *Secretary.*

Program

Monday, December 27, 8.00 p. m.

Address by the Chairman, E. F. Phillips, Washington, D. C.

Reading of Papers and Discussions

"The Desirability of Inspection Work from the Standpoint of Queen Breeders," by E. R. Root, Medina, Ohio.

"Some Difficulties in Cross Diagnosis of Disease," by A. H. McCray, Washington, D. C.

"Outline of Apiary Inspection in Ontario," by Morely Pettit, Guelph, Ontario.

"Suggestions for Efficiency and Economy in Apiary Inspection Service," by H. A. Surface, Harrisburg, Penn.

Adjournment.

Program

Tuesday, December 28, 10.00 a. m.

Discussion of the Presidential Address.

Reading of Papers

"The Columbine Leaf Miner," by E. N. Cory, College Park, Md. (10 minutes.)

Life and seasonal history. Control.

"Observations on the Turnip Louse," by F. B. Paddock, College Station, Texas. (15 minutes.)

Bionomical observations made upon this insect in Texas during two years' study of the pest.

"Fumigation of Animals to Destroy their External Parasites," by William Moore, University Farm, St. Paul, Minn. (15 minutes.)

An account of a new material which can be used to fumigate animals and destroy their parasites without injury to the animal.

"The Clover Leaf Tyer, *Ancylis angulifasciana*," by H. A. Gossard, Wooster, Ohio. (7 minutes.) Lantern.

Life history, character of damage and control.

"*Dasyneura ulmea* Felt, an Elm Pest," by J. S. Houser, Wooster, Ohio. (5 minutes.) Lantern.

Causes malformations on the terminal twigs of elm.

Adjournment.

Program

Tuesday, December 28, 1.30 p. m.

Reading of Papers

"A New Method of Subterranean Fumigation," by J. S. Houser, Wooster, Ohio. (12 minutes.) Lantern.

"Sulphur-Arsenical Dusts Against the Strawberry Weevil," by T. J. Headlee, New Brunswick, N. J. (15 minutes.) Lantern.

Among the fifteen different treatments given the plants just as the weevils begin their work; the sulphur arsenical dusts gave the best results and afforded a high degree of protection.

"The Effect of Contact Insecticides on the Larvæ of Syrphidæ, by C. L. Metcalf, Columbus, Ohio. (7 minutes.)

"The Accurate Determination of the Nicotine Content of Spraying Solutions," by V. I. Safro, Louisville, Ky. (15 minutes.)

"Arsenic on Fruit and Forage Following Spraying," by Walter C. O'Kane, Durham, N. H. (15 minutes.) Lantern.

Sheep poisoning; Loss of lead arsenate residues on hay; maximum residues on fruit; conclusions as to factors determining amount of residues.

"The Control of the Grape Berry Worm, *Polychrosis viteana*," by W. H. Goodwin, Wooster, Ohio. (10 minutes.) Lantern.

This paper deals with the life history in northern Ohio and the development of control methods for the berry worm.

"Notes on the Control of the Lesser Peach-tree Borer," by J. L. King, Cleveland, Ohio. (15 minutes.) Lantern.

Cultural methods such as pruning and cultivation; also time to "worm the trees."

"Climate and Variations in the Habits of the Codling Moth," by E. P. Felt, Albany, N. Y. (10 minutes.)

This paper is concerned chiefly in recording variations observed in New York State and attempts to explain these by local variations in temperature.

"Life History of the Pecan Twig Girdler," by S. W. Bilsing, College Station, Texas. (15 minutes.) Lantern.

The life history of the pecan twig girdler (*Oncideres texana*); methods of control; injury done; food plants, etc.

Adjournment.

SECTION OF HORTICULTURAL INSPECTION

W. E. Rumsey, *Chairman.* J. G. Sanders, *Secretary.*

Program

Tuesday, December 26, 8.00 p. m.

(Detailed program of this section will be available at the meeting.)

Wednesday, December 29, 10.00 a. m.

(Detailed program will be available at the meeting.)

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Program

Wednesday, December 29, 1.30 p. m.

Reading of Papers

"Notes on Crambidæ," by George G. Ainslie, Nashville, Tenn. (5 minutes.)

A brief outline of the economic significance of Crambidæ and notes on the work carried on at Nashville.

"A Study of the Life History of the Maize Bill Bug," by Wm. P. Hayes, Manhattan, Kans. (12 minutes.) Lantern.

Distribution in Kansas, economic importance, life history and habits, and methods of control.

"The Small Pink Corn Worm, *Batrachedra rileyi*, in Mississippi," by R. W. Harned, Agricultural College, Miss. (5 minutes.)

Brief notes on occurrence of this insect in Mississippi. It must be ranked as a pest of considerable importance.

"The Economic Status of the Seed Corn Maggot, *Pegomyia fusciceps*," by W. J. Schœne, Blacksburg, Va. (8 minutes.)

A discussion of the food plants and the condition of the food attacked.

"Records of Lachnosterna in Wisconsin," by J. G. Sanders, Madison, Wis. (15 minutes.) Lantern.

Report on the results of using trap lanterns for capturing May beetles.

"A Progress Report on White Grub Investigations," by John J. Davis, West Lafayette, Ind. (10 minutes.)

Summary of Lachnosterna investigations to date.

"Notes on Pegomyia hyoscyami Panz.," by E. N. Cory, College Park, Md. (10 minutes.)

Life and seasonal history.

"Notes on the Biology of *Pegomyia brassicœ* Bouche," by W. J. Schœne, Blacksburg, Va. (10 minutes.)

A presentation of the more important observations on the life history of the species.

"An Investigation of the Supposed Immunity of Some Varieties of Wheat to the Attack of Hessian Fly," by L. Haseman, Columbia, Mo. (15 minutes.)

A brief summary of the first year's work, including data collected from plots of different varieties of wheat grown side by side, together with notes on some chemical and physiological variations in the different varieties.

"The Hessian Fly Train," by George A. Dean, Manhattan, Kans. (12 minutes.) Lantern.

A brief account of the Hessian fly infestation in the state; the organization of the special train; how the train was conducted and the results accomplished.

"County Coöperation to Prevent Hessian Fly Damage," by H. A. Gossard, Wooster, Ohio. (5 minutes.)

This paper describes a method by which an entire county was kept solidly in line, almost no one sowing until advised by the county agent and Station Entomologist to do so.

Adjournment.

Program

Thursday, December 30, 10.00 a. m.

Reading of Papers

"Dispersion of *Musca domestica* Linnæus under City Conditions," by Ralph R. Parker, Bozeman, Mont. (15 minutes.) Lantern.

An account of dispersion experiments conducted on a large scale.

"An Appreciation of the Hawaiian Parasite Introduction Work," by L. O. Howard, Washington, D. C. (15 minutes.) Lantern.

A brief account of observations made and facts learned on a visit to Oahu in August, 1915—an effort to show more emphatically than has hitherto been done, the importance of the results accomplished.

"Life History and Habits of Two New Nematodes Parasitic on Insects," by Joseph H. Merrill, Manhattan, Kans. (12 minutes.)

One of these nematodes is parasitic upon *Saperda tridentata* and the other upon *Leucotermes lucifigus.*

"Some Non-bacterial Insect Diseases," by J. W. Chapman, and R. W. Glaser, Forest Hills, Mass. (15 minutes.) Lantern.

Methods of diagnosis, distribution and etiological investigations.

Final Business

Report of committee on auditing.
Report of committee on resolutions.
Report of committee on membership.
Report of other committees.
Nomination of Journal Officers by Advisory Committee.
Report of committee on nominations.
Election of officers.
Miscellaneous business.
Fixing the time and place of next meeting.
Final adjournment.

A. F. Burgess, *Secretary,*
Melrose Highlands, Mass.

Glenn W. Herrick, *President,*
Ithaca, N. Y.

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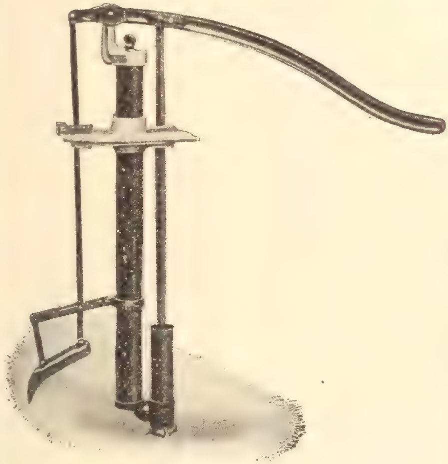

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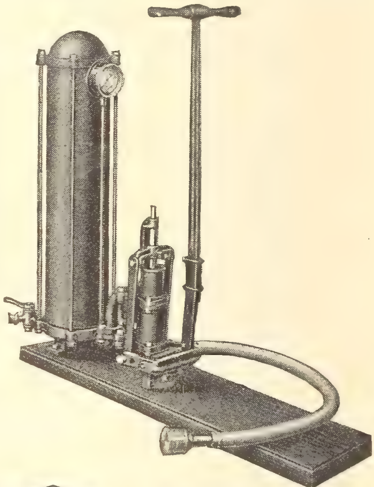

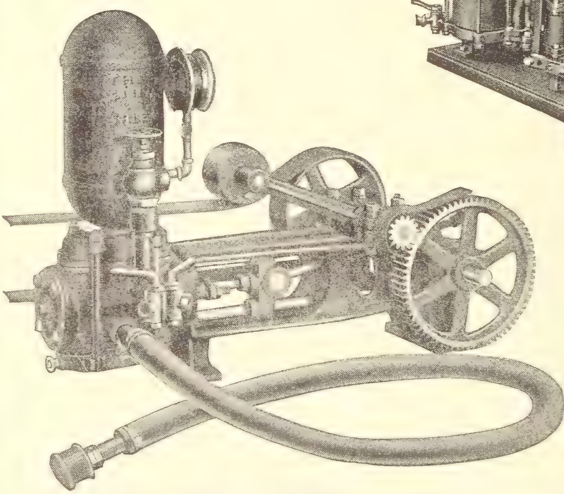

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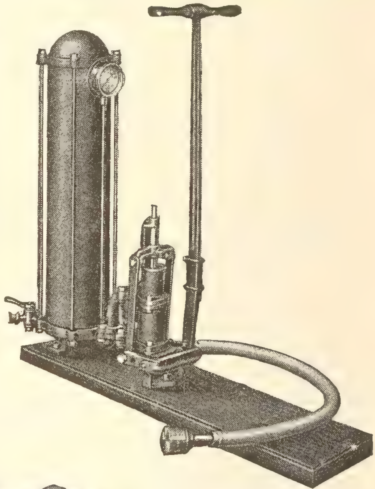

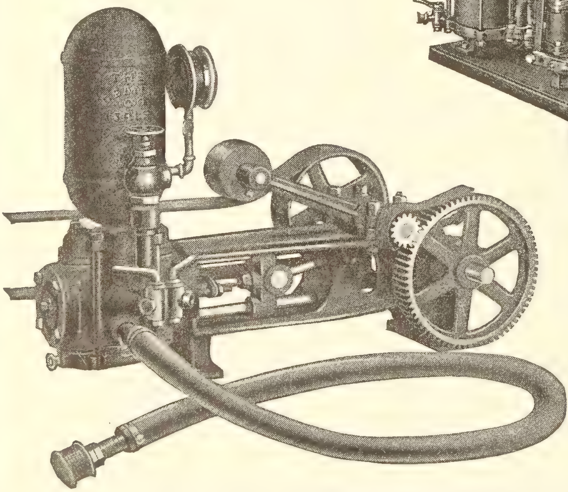

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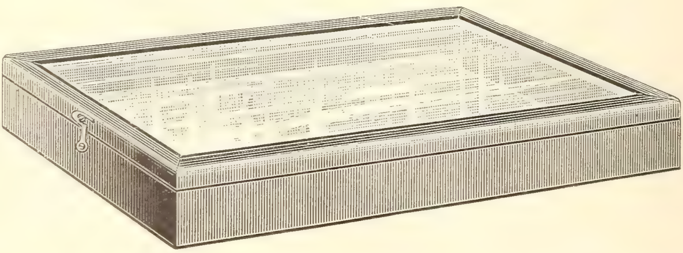

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